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CT-02-RI-D(2)-I

REMEDIAL INVESTIGATION

VOLUME I
TEXT

CALDWELL TRUCKING COMPANY SITE
TOWNSHIP OF FAIRFIELD, NEW JERSEY

EPA WORK ASSIGNMENT
NUMBER 69-2LB3
CONTRACT NUMBER 68-01-6699

NUS PROJECT NUMBER S796

JUNE 1986

CTC 001 0373

NUS CORPORATION

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DRAFT

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EXECUTIVE SUMMARY

Purpose of the Remedial Investigation

The objectives of the Remedial Investigation (RI) at the Caldwell Trucking Site, as outlined in the November 1984 Work Plan, are as follows:

- To better delineate the nature and extent of the site lagoons (since backfilled) and present holding tanks, with respect to the local topographic and geologic settings.

- To more fully characterize the wastes deposited at the site and the onsite contamination.

- To determine the nature and degree of contaminant migration off site and related environmental impacts and public health hazards.

The data gathered to meet these objectives will be used in performing the Feasibility Study of Remedial Alternatives.

Site Description, Background, and Problems

The Caldwell Trucking Company Site is located in Fairfield Township, Essex County, New Jersey. The site covers approximately 15 acres and is owned by the Caldwell Trucking Company.

The Caldwell Trucking Company has been at the site since 1933. It has handled domestic and industrial septic tank waste. Some of these wastes are believed to have contained solvents and other contaminants. The waste was chlorinated for disinfection with granular hypochlorite in open, unlined lagoons. Sludge from the

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lagoons was periodically cleaned out and disposed off site. Clarified lagoon water was transported to a disposal pond within the site area, and allowed to filter into the subsurface. Dumping at the Caldwell Trucking Company Site was discontinued in 1973 by the order of the New Jersey Department of Public Utilities (NJDPU).

Groundwater in Fairfield Township has been heavily contaminated. Widespread sampling of domestic, municipal, and industrial wells has revealed the presence of a variety of halogenated hydrocarbons. A plume of contamination extends about 4,000 feet in a northeasterly direction from the site toward the Passaic River. Many groundwater samples from this plume contain greater than 1,000 parts per billion (ppb) of total volatile organics.

Municipal Well No. 7 was found to be contaminated as early as 1980. The location of this well indicates that it is not in the downgradient direction of groundwater flow from the site. The contamination may have migrated to Well No. 7 from the site due to a complex groundwater flow regime in multiple aquifers and pumping effects, and/or may be due to contaminant sources other than the Caldwell Trucking Company Site.

Sampling and analysis of surface water and sediment in the area indicate widespread low-level contamination from volatile organics of water and sediment, and limited polychlorinated biphenyl (PCB) contamination of sediments. However, it appears that waste materials on the site are not the only source for offsite surface water and sediment contamination.

Drilling and soil sampling revealed concentrations of volatile organics, heavy metals, and PCBs in the parts per million range in subsurface soils at the site. Surface soils on the site were found to be contaminated with PCBs. These contaminated soils might act as a continuing source of contamination to groundwater via leaching and to the surrounding environment via runoff.

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Scope of the Investigation

In 1980, the New Jersey Department of Environmental Protection (NJDEP) began a groundwater quality study that included sampling industrial, private, and municipal water supply wells. The information generated in the NJDEP study was used in this investigation, as part of an extensive groundwater study in the vicinity of the site. This groundwater investigation, along with other investigations, consisted of nine events that occurred between March and November of 1985. The nine events included:

- Drilling and installation of monitoring wells (March through August 1985).
- Drilling and sampling of subsurface soils (May through July 1985).
- Sampling of residential wells, surface water and sediment, and wastes (May 1985).
- Surveying of onsite and offsite sampling locations, monitoring wells, and an onsite sampling grid (May, June, and November 1985).
- Onsite air sampling (June 1985).
- Two rounds of monitoring well sampling (July and September, 1985).
- Aquifer pumping test (August 1985).
- In-situ soil gas screening (September 1985).
- Sampling of surface soils.

Groundwater and surface water samples were analyzed for the Hazardous Substance List (HSL) compounds and geochemical parameters, such as carbonate, bicarbonate, chloride, and nitrate. Soil and sediment samples were analyzed for the HSL compounds. Water levels were measured in the monitoring wells on a regular basis during field activities. The analytical data base used in this report was developed from EPA-validated analytical results.

Major Findings

- Geology consists of unconsolidated glacial sediments overlying basalt bedrock.

- Groundwater occurs in both the glacial deposits and in fractured bedrock. The glacial deposits and bedrock are hydraulically connected.

- Regional groundwater flow in both aquifers is to the northeast, toward the Passaic River.

- There is a plume of contaminated groundwater extending from the site to the Passaic River. The lateral extent of the plume, to the northwest, is not well defined at this time.

- Hydraulic gradients in the area, in both aquifers, are influenced by pumping of local industrial and municipal water supply wells.

- Chlorinated aliphatic compounds are the major groundwater contaminant in the area. Of these, trichloroethylene and related compounds constitute the greatest proportion.

- Surface soils throughout the site are contaminated with varying levels of PCBs and lead.

- Onsite subsurface soils in the former lagoon areas are contaminated with chlorinated aliphatic and polynuclear aromatic hydrocarbons and lead.

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- *Surface water and sediments in the vicinity of the site are contaminated* to varying degrees with contaminants similar to those detected on the site. However, all but one location are most likely contaminated from sources other than the Caldwell Trucking Company Site.

- Groundwater contamination was detected during this study upgradient of the site in the area of Municipal Well No. 7, downgradient of the site, and at the site. Groundwater contamination was not detected in monitoring wells between the site and Municipal Well No. 7.

- Groundwater flow in the area of the site is significantly influenced by industrial and municipal pumping wells near the site. Pumping of Municipal Well No. 7, at 390 gpm for an extended period, reversed the hydraulic gradient between the site and the well.

- Contaminated groundwater discharge is not currently or expected to significantly affect water quality of the Passaic River.

- *The major health risk at the site is associated with ingestion or domestic* use of contaminated groundwater. Although there are no data that indicate the human receptors in the plume are currently exposed to significant levels of contaminants in drinking water, any receptor in the vicinity of the site may be exposed at some future time, as a result of localized pumping influences or dispersion of the contaminant plume.

- Direct contact with, or accidental ingestion of, contaminated onsite surface soils may be associated with chronic and carcinogenic health risks. Exposure to offsite surface water and sediment in the tributary of Deepavaal Brook is also of a concern.

- Environmental receptors (biota) may be affected by the site. Inorganic compounds are the primary contaminants of concern for aquatic biota. PCBs and lead in onsite and offsite surface soils and sediments could potentially affect terrestrial biota.

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Data Problems and Unresolved Data Needs

Data collected during the RI and evaluated for this report have highlighted additional areas of investigative needs that might affect the evaluation, implementation, and maintenance of certain potential remedial actions. These areas include the following:

- Analytical results from samples taken in the vicinity of the site indicate that sources of contamination, other than the Caldwell Trucking Company Site, are contributing to the environmental contamination in the site area. This study has focused on contaminant sources on the site proper and the offsite migration from those sources. However, data generated in this study and in previous investigations indicate that the General Hose Products facility is also a contributor to the groundwater contamination northeast of the site. More detailed investigation of this facility is necessary to determine the extent and magnitude of contamination on the property.

  Other areas of concern include surface water contamination in Deepavaal Brook, contamination of Well No. 7 and contamination of sediments in the unnamed tributaries and marshes flowing into Deepavaal Brook.

- Definition of the northwestern boundary of the contaminant plume will be beneficial. This will help to determine if contamination in this area is due to lateral spreading of the plume or some unidentified source to the southwest.

- Human receptors in the plume area must be identified. The survey conducted in this investigation will provide a basis for this through confirmation of responses and followup on the nonresponse.

1.0 INTRODUCTION

This Remedial Investigation (RI) report was prepared by the NUS Corporation Remedial Planning Office (REMPO), located in Pittsburgh, Pennsylvania. The United States Environmental Protection Agency (EPA) issued the work assignment on April 2, 1984, under Contract Number 68-01-6699 and Work Assignment Number 69-2LB3. This report describes the RI for the Caldwell Trucking Company Site, Fairfield Township, New Jersey, that was conducted as described in the EPA-approved Work Plan, dated November 1984.

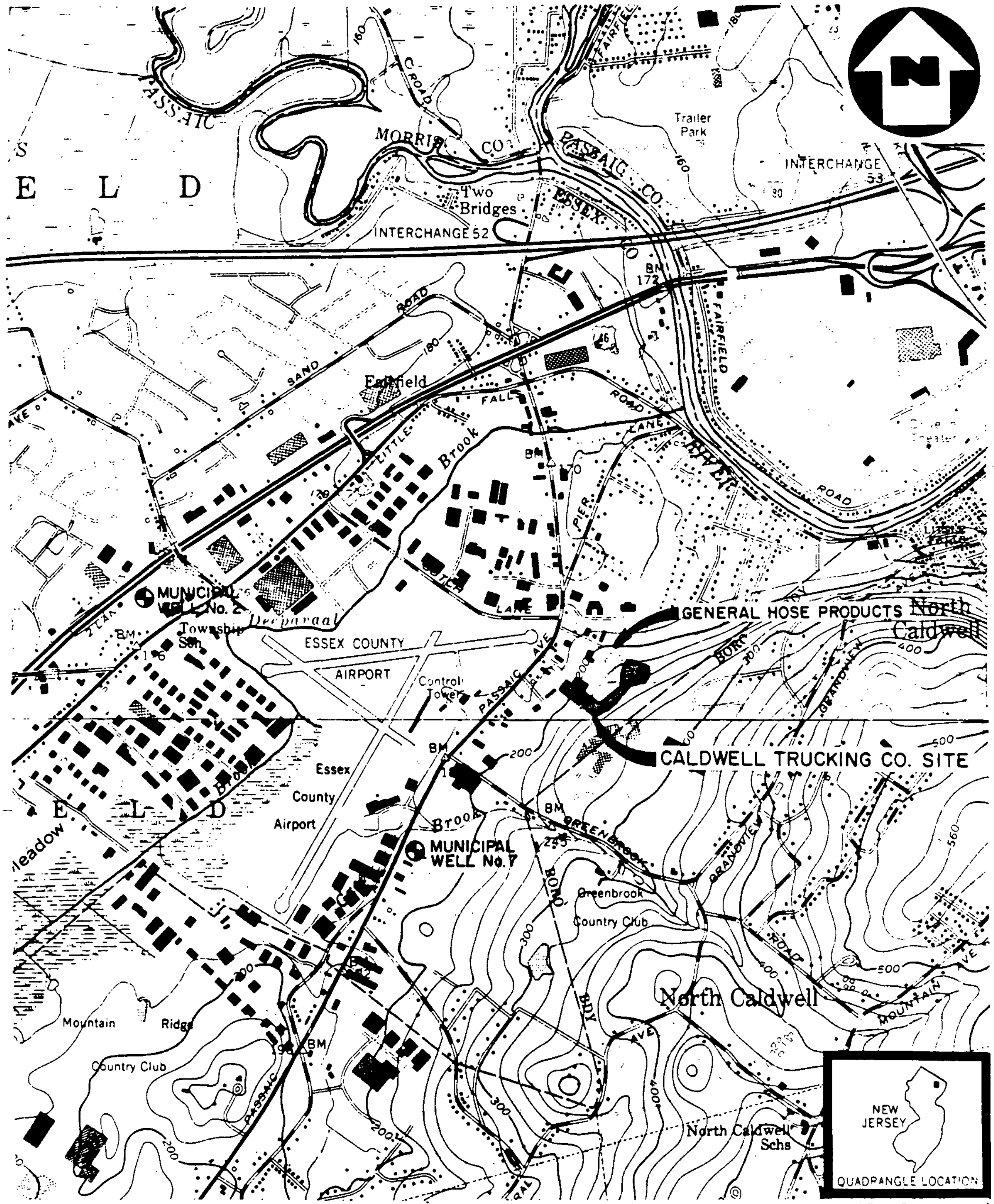
The objectives of this Remedial Investigation at the Caldwell Trucking Company Site, as outlined in the Work Plan, were as follows:

- To better delineate the nature and extent of the site lagoons (since backfilled), and present holding tanks with respect to the local topographic and geologic settings.
- To more fully characterize the wastes deposited at the site and the onsite contamination.
- To determine the nature and degree of contaminant migration off site and related environmental impacts and public health hazards.

1.1 Site Background Information

Location

The Caldwell Trucking Company Site (hereafter referred to as the site) is located in Fairfield Township, Essex County, New Jersey. The site is a 15-acre tract of land located in the eastern portion of the township, between O'Connor Drive and Sherwood Lane, immediately east of Passaic Avenue. Map coordinates for the site are latitude 40°53'23" north, longitude 74°16'16" west on the Pompton Plains 7.5 minute series quadrangle map, as shown on Figure 1-1.



BASE MAP IS A PORTION OF THE U.S.G.S. POMPTON PLAINS, NJ QUADRANGLE (7.5 MINUTE SERIES, 1955, PHOTOREVISED 1981) AND A PORTION OF THE CALDWELL, NJ QUADRANGLE (7.5 MINUTE SERIES, 1954, PHOTOREVISED 1981).
CONTOUR INTERVAL 20'.

FIGURE 1-1

LOCATION MAP

CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

SCALE: 1" = 2000'

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Site Description and History

Fairfield Township is situated on an extensive flood plain of the Passaic River. The flood plain is a low-lying area of little relief with numerous swampy sections. The site lies on a hillside near the junction of the flood plain and a prominent hilly area to the southeast. Maximum relief between the flood plain and the crests of major hills approaches 400 feet. Elevations on the site range from approximately 185 feet to 240 feet above mean sea level. The site layout is shown in Figure 1-2.

The Caldwell Trucking Company began operation at the site in 1946. It has handled domestic and industrial septic tank waste. Some of these wastes are believed to have contained solvents and other contaminants. The waste was chlorinated for disinfection with granulated hypochlorite in open, unlined lagoons. Sludge from the lagoons was periodically cleaned out and disposed off site. Clarified lagoon water was transported to an unlined disposal pond within the site area, and allowed to filter into the subsurface.

Dumping at the Caldwell Trucking Company Site was discontinued in 1973 on the order of the New Jersey Department of Public Utilities (NJDPU). At present the site is operated as a transfer facility that receives wastes in tank trucks and transports the waste for disposal. The site includes an office and four steel holding tanks having a total capacity of 80,000 gallons. The lagoons have been backfilled and closed.

Events leading to the inclusion of the Caldwell Trucking Company Site on the Superfund list began in the mid-1970s. At that time a number of domestic wells in the Township of Fairfield were found to be contaminated with chlorinated hydrocarbons. The investigation into the contamination intensified in 1980, when a well operated by Heisler Machine Company, adjacent to the site, was found to be heavily contaminated with many volatile organics, including trichloroethylene, chloroform, tetrachloroethylene, and others. The New Jersey Department of Environmental Protection (NJDEP) then began a groundwater quality study which included sampling industrial, private, and municipal water supply wells. Many of

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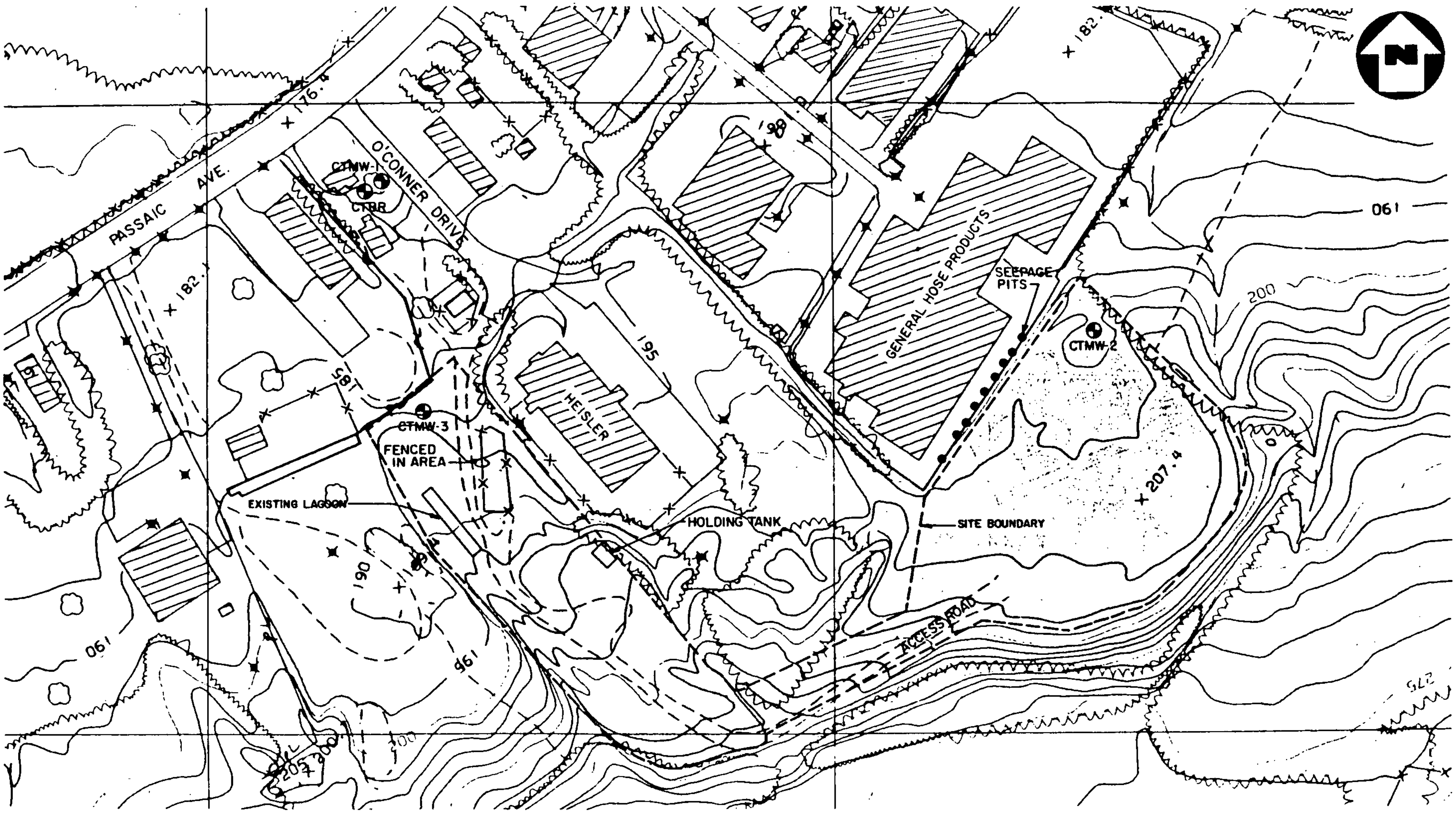

FIGURE 1-2

150 0 150
SCALE IN FEET

SITE LAYOUT
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

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these wells were found to be contaminated, as were Municipal Wells No. 2 and No. 7. These wells have been taken out of service and the majority of the residences with contaminated wells have been supplied with municipal water. Sampling of soils and sludges by NJDEP on the site revealed a possible source of contamination.

1.2 Nature and Extent of the Problem

Groundwater in northeastern Fairfield Township has been heavily contaminated. Widespread sampling of domestic, municipal, and industrial wells has revealed the presence of a variety of halogenated hydrocarbons. A plume of contamination extends about 4,000 feet in a northeasterly direction from the site, toward the Passaic River. Many groundwater samples from this plume contain more than 1,000 parts per billion (ppb) of total volatile organics.

Municipal Well No. 7 was found to be contaminated. The location of this well suggests that it is not in the downgradient direction of groundwater flow from the site. The contamination may have migrated to the well from the site because of a complex groundwater flow regime in multiple aquifers and pumping effects, and/or from contaminant sources other than the Caldwell Trucking Company Site. Well No. 2 was determined by NJDEP to be contaminated from a source not related to the site because it contained several contaminants that were not found on the site or in Municipal Well No. 7.

Surface water at the site flows into ditches that join Deepavaal Brook and into storm drains on adjacent roadways. Deepavaal Brook flows into the Passaic River. Sampling and analysis of surface water and sediment in the area indicates widespread, low-level, volatile organics contamination of water and sediment and limited PCB contamination of sediments. However, it appears that waste materials at the site are not the only source for offsite surface water and sediment contamination.

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Contaminated sludges, surface soil, and subsurface soil remain on the site. Drilling and soil sampling revealed concentrations of volatile organics, trace elements, and PCBs in the parts per million range in the former lagoon areas. Contaminated soil was found from 3 to 35 feet where bedrock was encountered. Site soils may act as a continuing source of contamination to groundwater via leaching.

1.3 Remedial Investigation Summary

The following Remedial Investigation activities have been conducted by NUS Corporation to meet the objectives stated previously.

- March through August 1985 - Drilling and installation of 19 monitoring wells to determine subsurface conditions, particularly southwest of the site, to provide observation wells for an aquifer pumping test, and to provide groundwater sampling points.

- May through July 1985 - Drilling and sampling of 18 soil borings in the former lagoon areas on site to characterize the vertical and horizontal extent of contamination in the areas.

- May 1985 - Sampling of 7 residential wells in the contaminant plume area northeast of the site; sampling of 7 of the 10 seepage pits behind the General Hose Products Inc. plant; sampling of 8 surface water and sediment locations in Deepavaal Brook, the Passaic River and other surface waters downstream of the site; and sampling of the 4 holding tanks and 1 existing lagoon on site.

- May, June, and November 1985 - Surveying of onsite and offsite sampling locations, monitoring wells, and an onsite sampling grid.

- June 1985 - Collection of six air samples on site during completion of soil boring B-1. This was done to provide air-quality data during ground disturbance on site.

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- July and September 1985 - Two rounds of monitoring well sampling. All 19 NUS monitoring wells and 6 existing monitoring wells were sampled each round.

- August 1985 - Aquifer pumping test of Municipal Well No. 7 to investigate the effect of long-term pumping of Well No. 7 on the hydraulic gradient between the site and the well. Onsite gas chromatography screening for volatile organics in the pumping well and selected monitoring well water samples was performed to monitor changes in contaminant concentrations during the test.

- September 1985 - In situ soil gas screening to investigate areas of surface and near surface soil contamination.

- October 1985 - Sampling of 18 surface soil and 10 sediment locations on site and off site. Onsite gas chromatography screening for volatile organics and PCBs was performed on these soil samples to provide rapid turnaround results.

1.4 Overview of Report

The remaining sections of this report are described below.

Section 2.0, Site Features, includes discussions on demography, land use, natural resources, and climate.

Section 3.0, Hazardous Substances Investigation, discusses the wastes disposed on the site, the areas of deposition, and the contaminants associated with the wastes in each area. A description of the field activities conducted to define the waste areas and characteristics is also included.

Section 4.0, Subsurface Investigation, presents site-specific information on soils, geology, and hydrogeologic characteristics. A detailed description of the NUS field

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activities associated with the subsurface investigation, as well as chemical analytical results for soils and groundwaters, is also included.

Section 5.0, Surface Water, presents chemical analytical results for surface water and sediment along with information on drainage and flood potential at the site.

Section 6.0, Air Sampling, presents the analytical results of air samples collected during onsite subsurface soil sampling activities.

Section 7.0, Environmental Transport and Migration of Contaminants, provides information on the movement of site-related contaminants in the various environmental media.

Section 8.0, Public Health and Environmental Concerns, discusses environmental and health risks associated with the site.

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2.0 SITE FEATURES

2.1 Demography

The Caldwell Trucking Company Site is located very close to several heavily populated residential areas. Figure 2-1 shows that, within a 1-mile radius, there are approximately 530 single-family homes. Using an estimate of 3 people per household, approximately 1,600 people live within 1 mile of the site. The closest residential dwelling is the site owner's residence, approximately 400 feet northwest of the site entrance. The next closest residential dwellings (approximately 320 homes) are located approximately 900 feet to the north. Within this group of dwellings, active water supply wells are being used to provide potable water for home use.

The project site is also located within a light industrial district. Approximately 45 small businesses are situated within the 1-mile radius. Several of these businesses have water wells that supply process water for the business. Also, several of the businesses use well water as their potable water for employees.

The nearest community facility to the project site is the Essex Regional High School, located approximately 200 feet to the east. This school has approximately 1,800 students in grades 7 though 12. The areas that this school serves include Fairfield, Roseland, North Caldwell, and Essex Fells. The school is supplied water from the North Caldwell Water Department which uses wells located in Essex Fells. Essex Fells is located approximately 3.5 miles south of the site.

2.2 Land Use

Land usage within a 1-mile radius of the site is predominantly industrial and commercial. These industrial areas are concentrated mainly to the southwest and northwest of the site. The Essex County Airport property is situated approximately 200 feet to the west of the project site access road.

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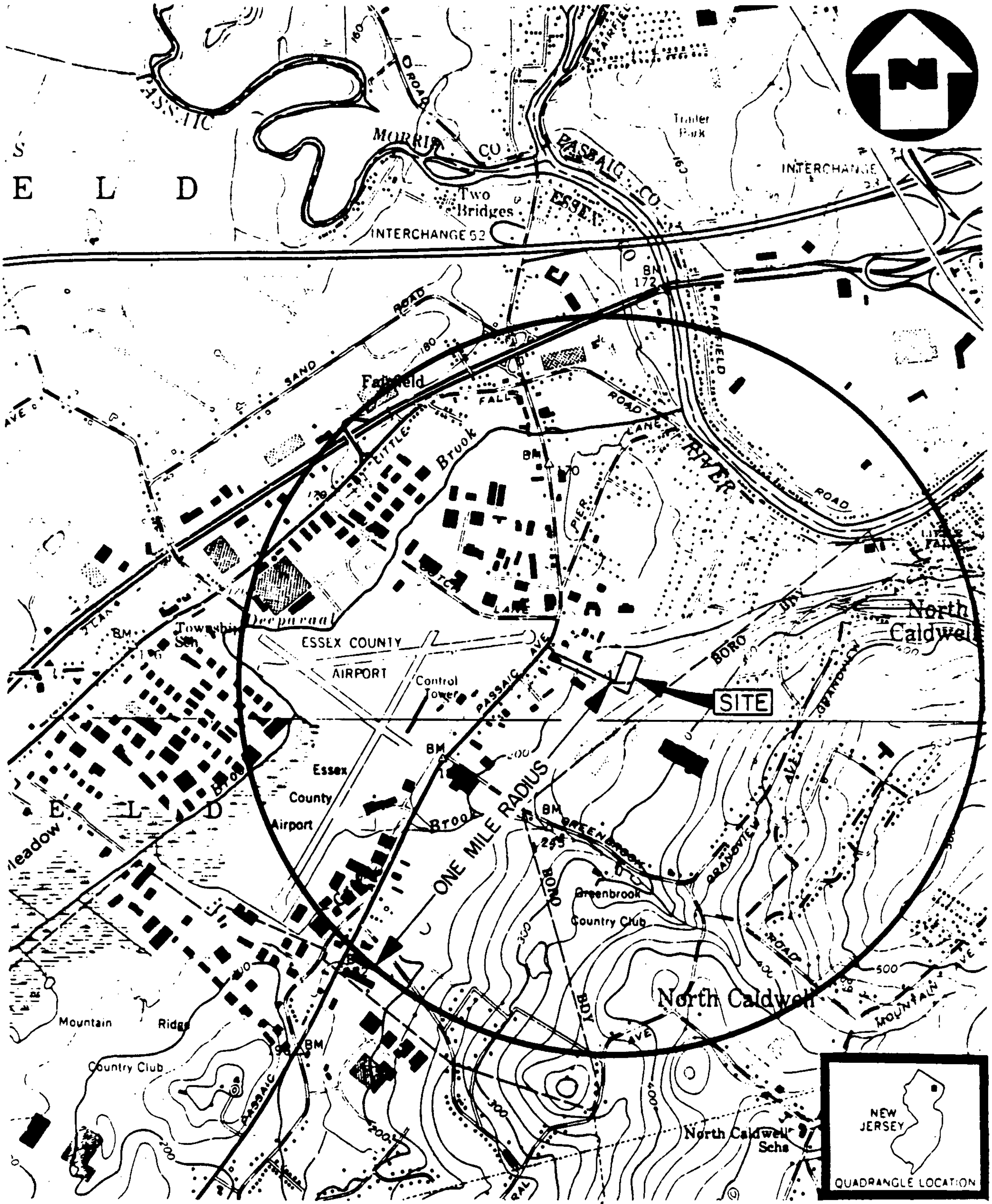

BASE MAP IS A PORTION OF THE U.S.G.S. POMPTON PLAINS, NJ QUADRANGLE (7.5 MINUTE SERIES, 1955, PHOTOREVISED 1981) AND A PORTION OF THE CALDWELL, NJ QUADRANGLE (7.5 MINUTE SERIES, 1954, PHOTOREVISED 1981). CONTOUR INTERVAL 20'.

FIGURE 2-1

LOCATION MAP SHOWING ONE-MILE RADIUS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

SCALE: 1" = 2000'

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Residential areas are the next largest land use category within the 1-mile radius. These areas are located to the north and east. As stated previously, the Essex Regional High School property is located to the east of the Caldwell Trucking Company Site.

In addition, small plots of forest and shrub/brush land make up approximately 1/5 of the land situated within the residential and industrial areas within the 1-mile radius near the site.

2.3 Natural Resources

The natural resources that have been or may be affected by contamination include the Passaic River and the aquifers that supply groundwater to municipal wells and private/industrial wells in the vicinity of the Caldwell Trucking Company Site.

The Passaic River is used as a water supply for communities down river of the site. The Passaic Valley Water Commission has a water intake located on the Passaic River, approximately 2.2 miles downstream of its confluence with Deepaval Brook. This water commission serves approximately 750,000 people.

Numerous residential wells north of the site are no longer in use and most of the residents now use municipal water. However, two Fairfield Township municipal wells (Nos. 2 and 7) are no longer used because of contamination. These wells are relatively high-yielding wells that provided a portion of the municipal water supply in Fairfield.

2.4 Climatology

The average monthly temperatures and precipitation for Newark, New Jersey, about 12 miles east-southeast of the Caldwell Trucking Company Site, the nearest National Oceanic and Atmospheric Administration (NOAA) weather station, are as follows (NOAA 1981):

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Month	Temperature (°F)	Precipitation (Inches, Rainfall Equivalent)
January	31.4	2.91
February	32.6	2.95
March	40.6	3.93
April	51.7	3.44
May	61.9	3.60
June	71.4	2.99
July	76.4	4.03
August	74.6	4.27
September	67.8	3.44
October	57.5	2.82
November	46.2	3.61
December	34.5	3.46

Average Yearly Temperature 53.9 Average Yearly Precipitation 41.45

The prevailing winds are from the southwest at an average of 10.2 miles per hour.

Site-specific precipitation and barometric pressure measurements taken from mid-July through the end of August can be found in Appendix B.

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United States Environmental Protection Agency, 1984. Site Analysis, Caldwell Trucking Company, Fairfield, New Jersey. Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

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3.0 HAZARDOUS SUBSTANCES INVESTIGATION

3.1 Sampling and Analysis

Waste deposition areas were investigated extensively on the Caldwell Trucking Company property and to a limited extent on the General Hose Products, Inc. property. The objectives of these investigations were to better define the areas on site where wastes are known to have been deposited, to investigate the nature of the wastes through chemical analysis, and to determine the presence or absence of chemical contamination in the seepage pits on the General Hose Products, Inc., property.

The areas of concern are shown in Figure 3-1 and include the buried tanks, existing lagoon, and former lagoons on the site, and the seepage pits located adjacent to the General Hose Products, Inc. plant.

3.1.1 Holding Tanks

The total capacity of the onsite holding tanks is approximately 80,000 gallons. Tank sampling locations are shown in Figure 3-2. Tanks A and B are steel tanks with access ports as shown. Because Tank A was empty at the time of sampling, a wipe sample of the side was taken from the inside surface. Tank B had about 1 foot of water and about 1 inch of sediment in it; both media were sampled. Tank C is also a steel tank but had no above-ground access and was not sampled. Tank D is apparently precast concrete open at the top with a plywood cover on it. It contained about 14 inches of water and 2 inches of sediment; both media were sampled. All tank samples were analyzed for Hazardous Substance List (HSL) organic and inorganic compounds. The results are presented in Appendix A.

3.1.2 Seepage Pits

Seepage pit locations are shown in Figure 3-1. The pits range from 6 to 8 feet deep and are approximately 6 to 8 feet in diameter. Pits 4, 5, and 6 could not be

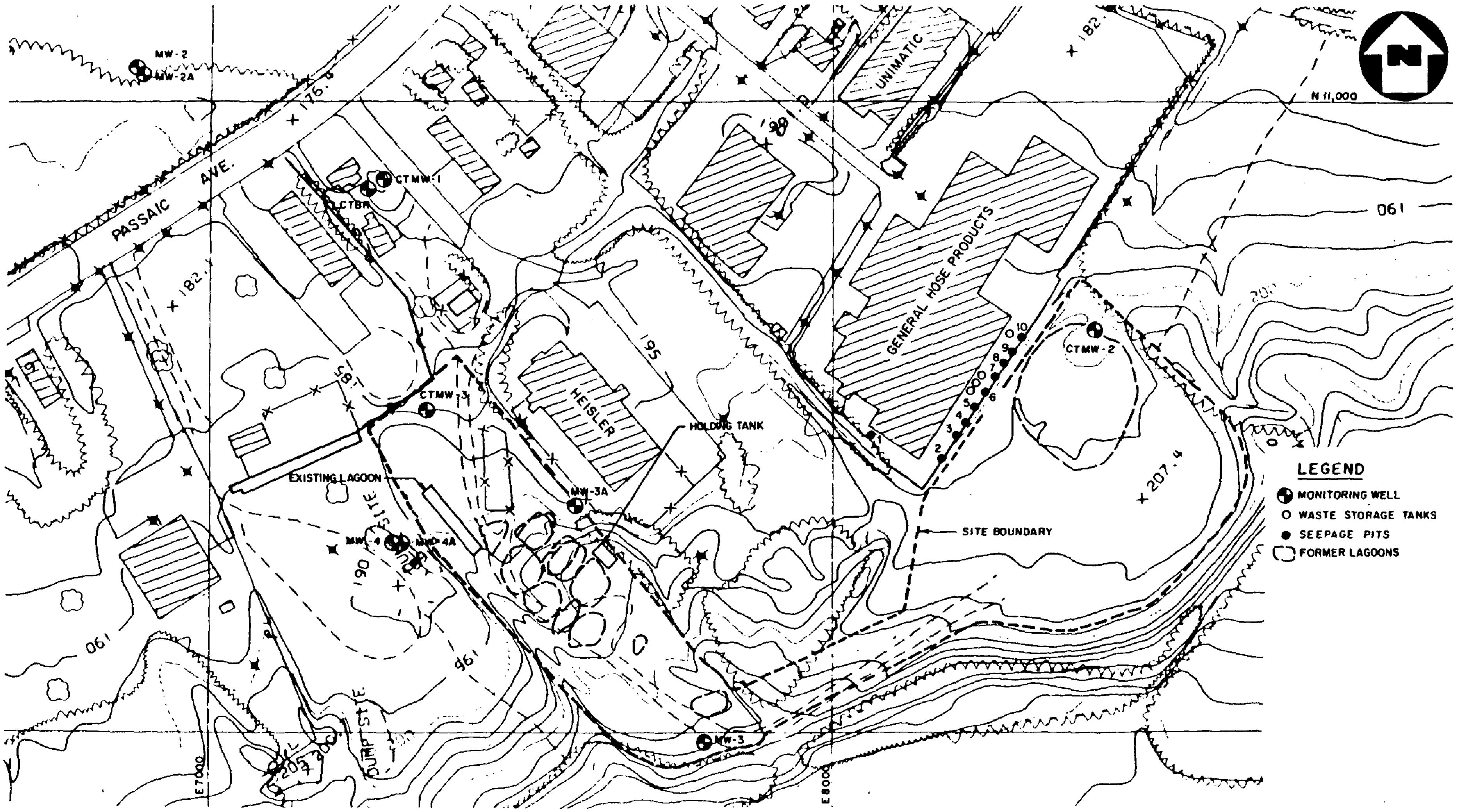

FIGURE 3-1

WASTE SAMPLING LOCATIONS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

150 0 150
SCALE IN FEET

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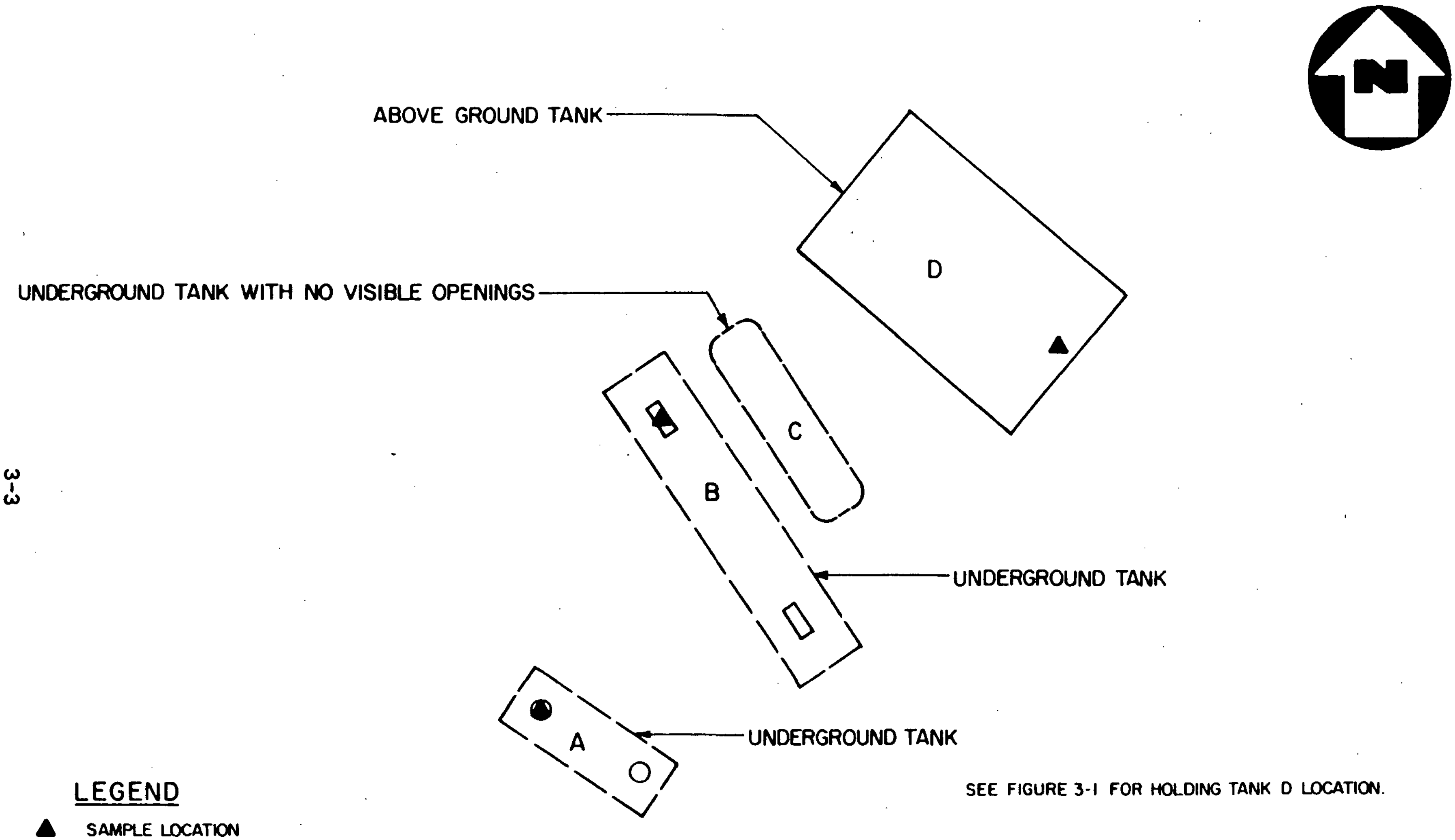

FIGURE 3-2

HOLDING TANK SAMPLING LOCATIONS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ
NOT TO SCALE

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opened. Pits 1, 2, 3, 7, 8, 9, and 10 were sampled. Pits 1, 2, 3, and 7 contained 1 to 3 feet of water; the rest were dry, while all 7 contained varying amounts of sediment. Both media were sampled if present. All samples were analyzed for HSL organic and inorganic compounds. The results are provided in Appendix A.

3.1.3 Existing Lagoon

The existing lagoon is covered by plywood, with the bottom of the lagoon about 3 feet below ground surface. No liquid phase was present. Five solid samples were taken from the surface of the lagoon bottom, at the locations shown in Figure 3-3. These samples were analyzed for HSL organic and inorganic compounds. The results are provided in Appendix B.

3.1.4 Former Lagoons

The approximate locations of the former lagoons are shown in Figure 3-1. The areas were mapped using historical aerial photographs contained in the Environmental Photographic Interpretation Center (EPIC) Study for this site. The lagoons were sampled as part of the subsurface investigation using a drilling rig and split spoon sampler. The drilling locations were determined from a surveyed grid established on the lagoon areas. Locations of the soil borings, details of the sampling, and the results will be provided in Section 4.0.

3.2 Waste Types and Locations

3.2.1 Holding Tanks

Four holding tanks are located on the Caldwell Trucking Company Site in the area adjacent to the Heisler Machine Company, as shown in Figure 3-1. These tanks were evidently used for temporary storage of septage wastes prior to disposal. The nature of the wastes placed in these tanks is presumed to be similar to those known to have been placed in the existing and former lagoons.

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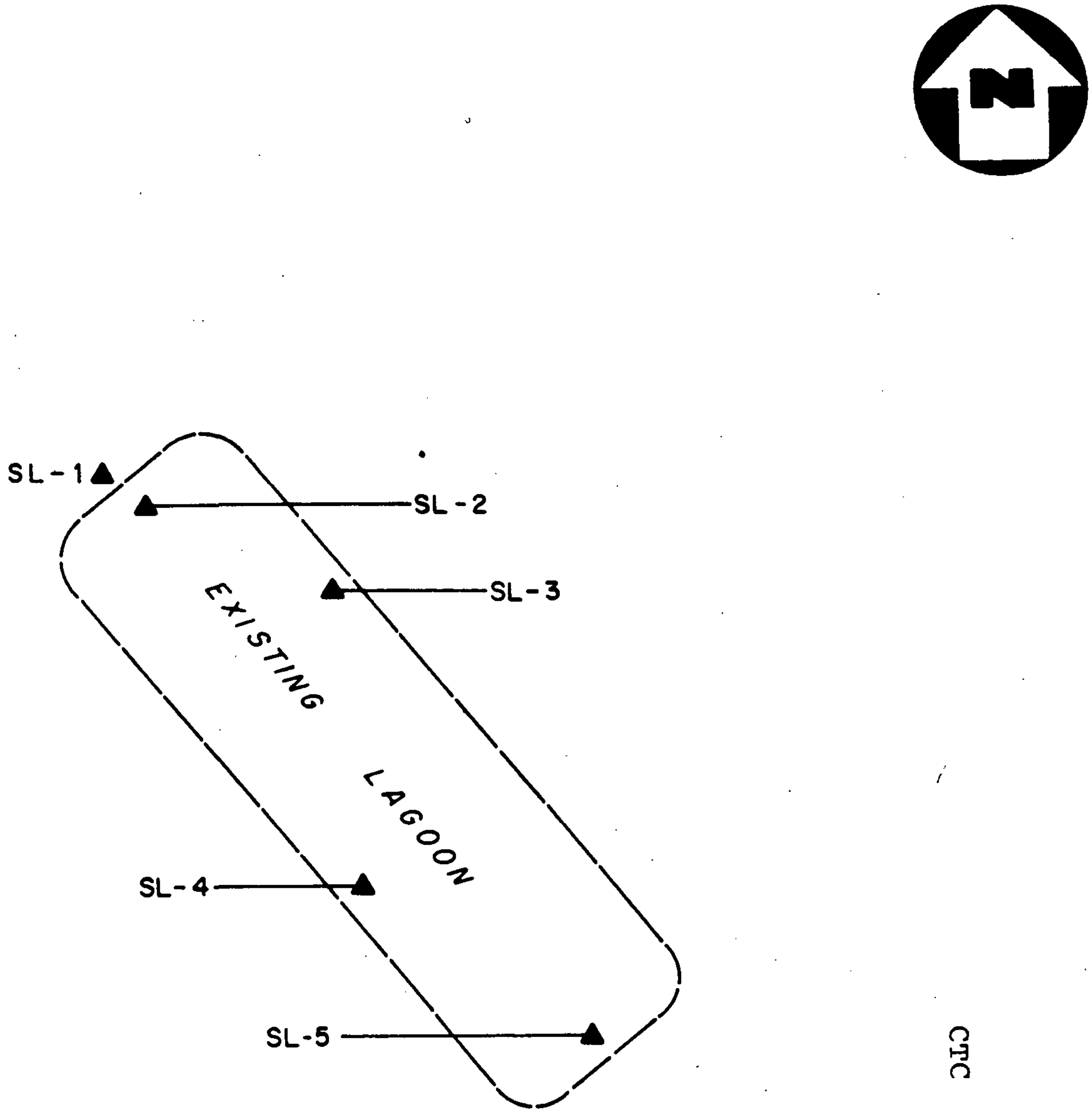

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LEGEND

▲ SAMPLE LOCATION

SEE FIGURE 3-1 FOR EXISTING LAGOON LOCATION

FIGURE 3-3

EXISTING LAGOON SAMPLING LOCATIONS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ
NOT TO SCALE

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Table 3-1 shows the maximum concentrations of contaminants detected in the holding tanks.

Sediment samples collected from Tank D (see Figure 3-2) were highly contaminated with chlorinated aliphatics, ketones, monocyclic aromatics, polynuclear aromatics (PAHs), phthalate esters, PCBs (Aroclors), and metals. However, the water sample collected from Tank D (TKW-001 and 001A) exhibited only one volatile, methylene chloride (1,000 µg/l), in addition to Aroclor-1242 at 6 µg/l.

Sediment and water samples collected from Tank B (Figure 3-2) contain some of the same contaminants as Tank D, but at lower concentrations.

Tank A was empty at the time of sampling but a wipe sample taken from this tank indicated the presence of Aroclor-1016.

3.2.2 Seepage Pits (General Hose)

Samples collected from the seepage pits, primarily the sediment samples, revealed volatile-organic contamination and one ocurrence of PCBs (Aroclor-1254 at 4,633 µg/kg). Total volatile organics ranged from 46 µg/kg in pit 1 to 26,760 µg/kg in pit 7. Volatiles detected in the sediment samples included methylene chloride, acetone, 1,1-dichloroethane, trans-1,2-dichloroethane, 1,1,1-trichloroethane, trichloroethane, tetrachloroethene, and toluene. Other volatiles, in lower concentrations, were detected in seepage pits 1 through 3.

Waste-solvent storage tanks are situated behind General Hose Company in the vicinity of seepage pits 7 through 10. Inspection of these tanks in the past revealed leakage (NJDEP, 12/10/82). The waste-solvents known to be stored in these tanks, including trichloroethene, trichloroethane, tetrachloroethane, and methylene chloride, make up 82 percent of the volatile organics detected in seepage pits 7 through 10. It is not known whether General Hose discharged waste solvents

TABLE 3-1

MAXIMUM CONCENTRATIONS OF CONTAMINANTS DETECTED IN HOLDING TANK SAMPLES CALDWELL TRUCKING COMPANY SITE

Contaminant	Concentration			
	Tank D		Tank B	
	Water µg/l	Sediment µg/kg	Water µg/l	Sediment µg/kg
Volatiles				
methylene chloride	1,000	26,000	220	140
acetone	ND	13,000	ND	ND
carbon disulfide	ND	ND	ND	500
1,1-dichloroethane	ND	2,200	ND	ND
trans-1,2-dichloroethene	ND	290,000	ND	ND
toluene	ND	16,000	ND	140
ethylbenzene	ND	2,200	ND	ND
xylenes	ND	2,000	ND	ND
Base/Neutral Extractables				
chlorobenzene	ND	ND	ND	8,800
1,4-dichlorobenzene	ND	10,000	ND	ND
1,2-dichlorobenzene	ND	14,000	ND	ND
1,2,4-trichlorobenzene	ND	11,000	ND	ND
naphthalene	ND	3,600	ND	ND
pyrene	ND	18,000	ND	ND
benzo(b)fluoranthene	ND	36,000	ND	ND
bis(2-ethylhexyl)phthalate	ND	280,000	ND	40,000
Acid Extractables				
4-methyl phenol	ND	120,000	ND	ND
PCBs/Pesticides				
Aroclor-1242	6	2,790,771	ND	8,163
Aroclor-1248	ND	ND	ND	16,464
Aroclor-1016	ND	ND	ND	ND
heptachlor	ND	ND	0.16	ND
aldrin	ND	ND	0.2	ND
Metals				
mercury	ND	ND	ND	5

ND = not detected

CTC 001 0405

through this system in the past, though floor drains and sinks may have provided a travel route for volatiles to reach the seepage pit system.

3.2.3 Existing Lagoon

Samples collected from this lagoon (Figure 3-3) exhibit an assortment of HSL organics and elevated levels of metals. Volatile organic concentrations in these sludge samples were relatively low in comparison to other site media. Location SL-5 demonstrated the highest volatile concentration (TVO = 2,324 µg/kg); however 6 µg/kg TVO were present at location SL-2. Volatiles on the surface of this lagoon are likely to have volatilized to the atmosphere or leached to the subsurface.

High concentrations of chlorinated benzenes are present at locations SL-5 and SL-4. Respective concentrations are as follows: 1,2-dichlorobenzene (1,900 µg/kg and 780 µg/kg); 1,3-dichlorobenzene (2,400 µg/kg and 1,400 µg/kg); and 1,4-dichlorobenzene (2,900 µg/kg and 1,100 µg/kg).

Aroclor-1016 was detected at location SL-3 at 14,000 µg/kg and at location SL-5 at 10,400 µg/kg.

All samples from locations SL-2 through SL-5 exhibited elevated levels of arsenic (range 285 to 3,905 mg/kg), barium (range 221 to 20,445 mg/kg) and lead (range 1,436 to 144,902 mg/kg).

A surface-soil sample collected from immediately adjacent to the lagoon (SL-1) revealed none of the volatile contamination detected in the lagoon. However, many of the base/neutrals and primarily polynuclear aromatics detected in the lagoon, were detected in this sample. The lead concentration in this soil was 132,553 µg/g.

CTC 001 0406

4.0 HYDROGEOLOGIC INVESTIGATION

This section presents and discusses the subsurface investigations conducted for the RI at the Caldwell Trucking Company Site. Field activities performed for this RI and the interpretations of geology and hydrogeology as they relate to potential contamination and remedial alternatives are also presented.

4.1 Field Activities

Geologic and hydrogeologic information was obtained by drilling and installing monitoring wells, conducting a large-scale pumping test, drilling and sampling test borings on site, and collecting surface soil samples on site. This work lasted from March 11 through October 11, 1985.

Test Borings

A total of 18 test borings were drilled using cable-tool drilling methods. Split-spoon sampling and standard penetration tests were conducted in accordance with ASTM D1586-67 in the unconsolidated sediments. Samples were used to describe subsurface conditions and identify contaminated materials.

Sampling intervals ranged from greater than 20 feet to continuous sampling in the borehole. These intervals were determined in the field by the NUS representative and were based upon geologic materials and contamination encountered during drilling. Locations of the test borings on site are shown on Figure 4-1. Logs for these test borings are provided in Appendix B.

Monitoring Wells

A total of 19 monitoring wells were installed at 12 locations in the site area. Cluster wells (more than one well), located in separate borings, were placed at seven of these locations. Single wells were placed at the remaining five locations.

CTC 001 0407

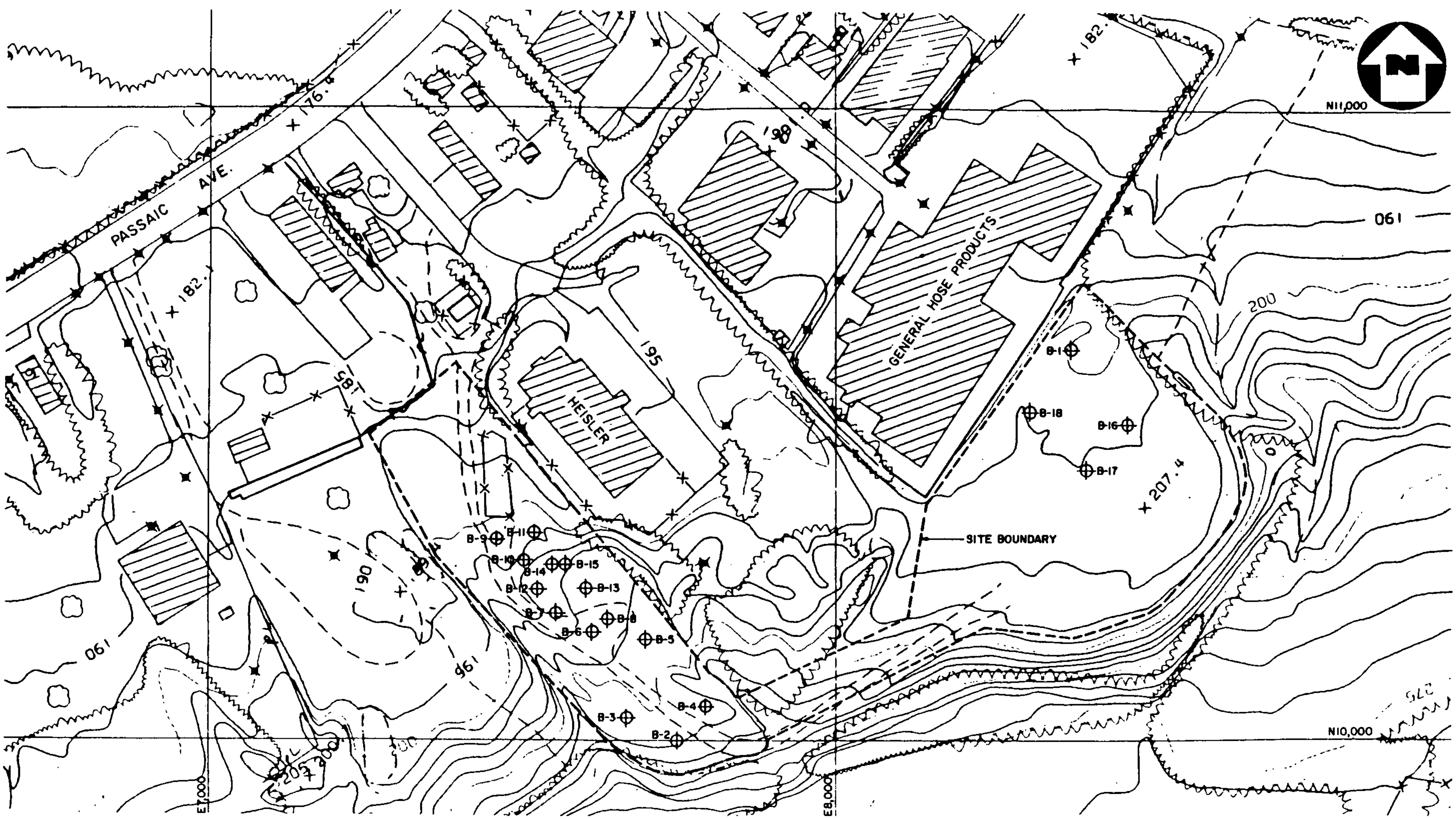

FIGURE 4-1

TEST BORING LOCATION MAP
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

150 0 150
SCALE IN FEET

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CTC 001 0408

At five of the cluster well locations, one well was completed into bedrock. The adjacent well was completed into the unconsolidated sediments above the bedrock. At the remaining cluster well locations, near the Passaic River, all wells (piezometers) were completed into the unconsolidated sediments at varying depths.

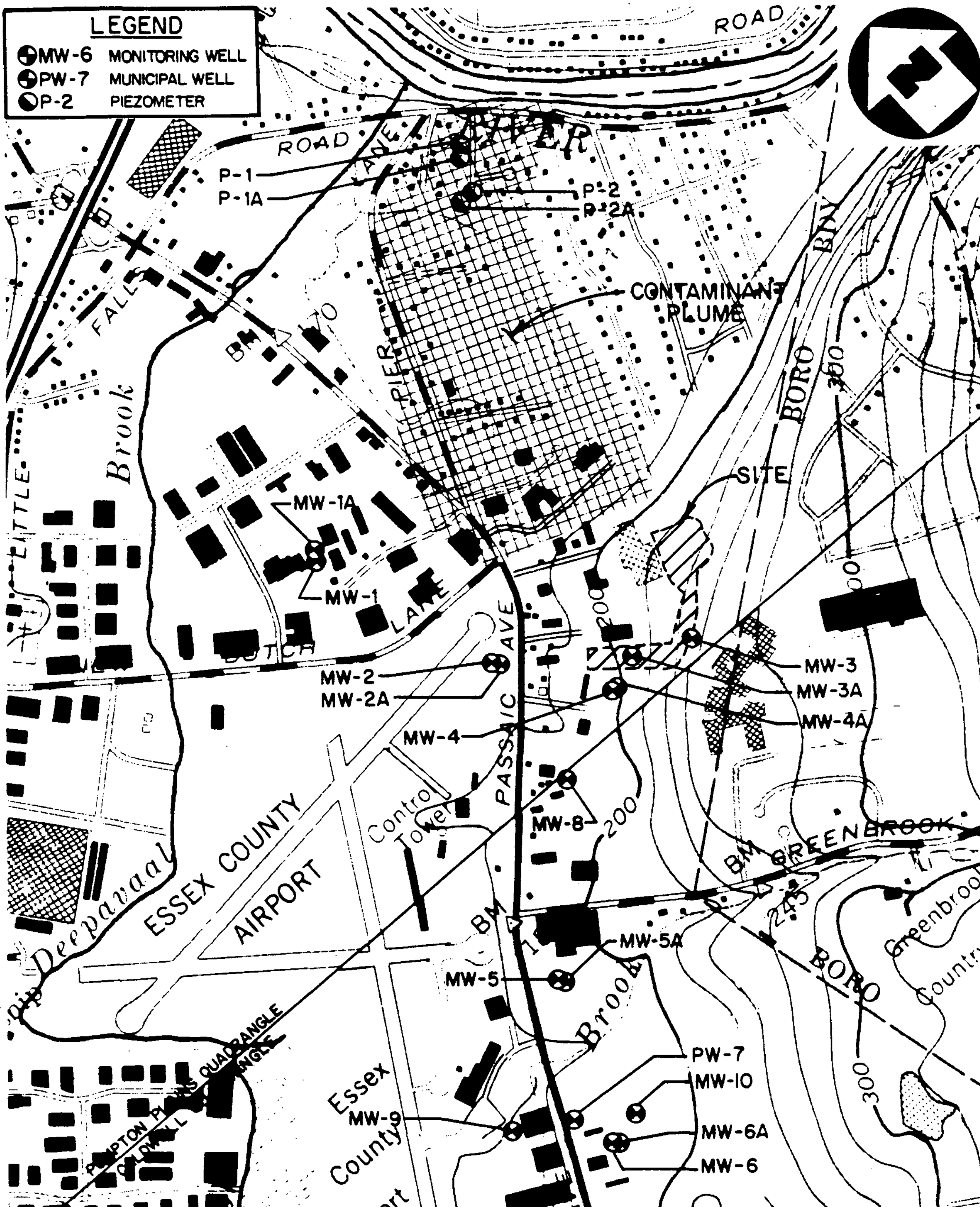
The locations of the monitoring wells are depicted in Figure 4-2. Table 4-1 summarizes the construction data for these wells and existing wells in the site area. Boring logs and monitoring well schematics are provided in Appendix B.

Bedrock wells were initially drilled through the unconsolidated material, 5 to 10 feet into bedrock using mud rotary or cable-tool drilling methods. Potable water, obtained from a Fairfield Township fire hydrant, located at the entrance to the project site, was used for the mud rotary drilling operations. Split-spoon samples were taken in some borings to describe subsurface conditions and identify contaminated materials. A 6-inch permanent steel casing was installed and grouted from bedrock to the ground surface to seal the bedrock from overlying sediments. These borings were then advanced through the bedrock using a 5-5/8-inch-diameter air-hammer drill. Cuttings samples from the drilling operations were obtained at 5- to 10-foot intervals and logged by the NUS geologist. After drilling, the open-borehole monitoring wells were developed using air surging and pumping techniques. These bedrock wells were labelled MW-1, 2, 3, 4, 5, 6, 8, 9, and 10.

Wells completed into the unconsolidated sediments were drilled using cable-tool drilling methods. Split-spoon samples were taken in borings, where possible, to define subsurface conditions and to identify contaminated materials.

Six monitoring wells, MW-1A, 2A, 3A, 4A, 5A, and 6A, were constructed from 4-inch-diameter stainless-steel riser pipe. Stainless-steel well screens, with a 0.010-inch slot size, were used in these wells. Wells were "packed" with "01" grade clean sand between the borehole and the outside of the screen. A seal was placed above the filter pack and screen using commercial grade bentonite pellets.

CTC 001 0409



BASE MAP IS AN ENLARGEMENT OF A PORTION OF FIGURE 2-1.

FIGURE 4-2

MONITORING WELL LOCATION MAP
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

SCALE: 1" = 1000'

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TABLE 4-1

SUMMARY OF WELL DATA
CALDWELL COMPANY TRUCKING SITE

Well No.	Elevation (FT-MSL) Ground Surface	Elevation (FT-MSL) Water Level Measuring Point	Well Diameter/ Type*	Bedrock Depth (FT)	Bedrock Elevation (FT-MSL)	Sampling Interval/Screen Setting Depth From	Depth To	Elevation (FT-MSL) From	Elevation (FT-MSL) To	Protective Casing Elevation (FT)	Geologic Unit
MW-1	169.16	170.89	5 5/8"/OB	55.0	114.16	71.8	110.8	97.36	58.36	170.89	Shallow Bedrock
MW-1A	168.83	171.40	4"/SS	60.0	108.83	42	62	126.83	106.83	171.40	Glacial Sediments
MW-2	174.05	176.06	5 5/8"/OB	70.0	104.05	74	122.75	100.05	51.3	176.06	Deep Bedrock
MW-2A	174.16	175.95	4"/SS	71.5	102.66	50.7	70.7	123.46	103.46	175.95	Glacial Sediments
MW-3	233.03	234.36	5 5/8"/OB	3.5	229.53	10.5	200.0	222.53	33.03	234.36	Deep Bedrock
MW-3A	193.18	195.04	4"/SS	39.7	153.48	29.7	39.7	163.48	153.48	195.04	Glacial Sediments
MW-4	190.29	192.25	5 5/8"/OB	44.0	146.29	52.5	260.7	137.78	-70.41	192.25	Deep Bedrock
MW-4A	190.28	192.24	4"/SS	44.0	146.28	23	43.0	167.28	147.28	192.24	Glacial Sediments
MW-5	189.31	190.35	5 5/8"/OB	76.0	113.31	85	303.0	104.31	-113.69	190.35	Deep Bedrock
MW-5A	188.99	190.95	4"/SS	76.0	112.99	56	76.0	132.99	112.99	190.95	Glacial Sediments
MW-6	186.71	188.00	5 5/8"/OB	55.0	131.71	65	303.0	121.71	-116.29	188.0	Deep Bedrock
MW-6A	189.12	190.94	4"/SS	44.0	145.12	24	44.0	165.12	145.12	190.94	Glacial Sediments
MW-8	191.27	192.58	5 5/8"/SS	55.0	136.27	58.5	283.5	132.77	-92.23	192.58	Deep Bedrock
MW-9	176.23	177.74	5 5/8"/SS	51.0	125.23	64.0	304.0	112.23	-127.77	177.74	Deep Bedrock
MW-10	187.15	189.76	5 5/8"/SS	69.0	118.15	80.0	282.0	107.15	-94.85	189.76	Deep Bedrock
P-1	169.22	170.38	2"/PVC	NA	NA	48.7	53.7	120.52	115.52	170.38	Glacial Sediments (Alluvial River Deposits)
P-1A	169.26	170.82	2"/PVC	NA	NA	6.54	11.54	162.72	157.72	170.82	Glacial Sediments (Alluvial River Deposits)
P-2	168.47	169.67	2"/PVC	65.0	103.47	58.5	63.5	109.97	104.97	169.67	Glacial Sediments (Alluvial River Deposits)
P-2A	168.26	169.67	2"/PVC	NA	NA	8.95	13.95	159.31	154.31	169.67	Glacial Sediments (Alluvial River Deposits)

CLC 001 0411

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TABLE 4-1
SUMMARY OF WELL DATA
CALDWELL TRUCKING COMPANY SITE
PAGE TWO

Well No.	Elevation (FT-MSL) Ground Surface	Elevation (FT-MSL) Water Level Measuring Point	Well Diameter/ Type*	Bedrock Depth (FT)	Bedrock Elevation (FT-MSL)	Sampling Interval/Screen Setting Depth From	Depth To	Elevation (FT-MSL) From	Elevation (FT-MSL) To	Protective Casing Elevation (FT)	Geologic Unit
NJDEP Wells											
CTMW-1	177.38	178.99	4"/PVC	24.0	153.38	20.0	30.0	157.38	147.38	178.99	Glacial Sediments and Shallow Bedrock
CTMW-2	198.95	201.68	4"/PVC	35.0	163.95	35.0	45.0	163.95	153.95	201.68	Glacial Sediments
CTMW-3	187.98	190.24	4"/PVC	34.0	153.98	25.0	35.0	162.98	152.98	190.24	Glacial Sediments and Shallow Bedrock
CT-BR	178.79	181.59	6"/OB	59.0	119.79	66.3	134.0	112.49	44.79	181.59	Shallow Bedrock
Fairfield Township											
Well No. 7	187.50	189.50	8"/OB	≃50	≃137.5	52.25	300.0	135.25	-112.5	NA	Deep Bedrock

* OB = Open Borehole
SS = Stainless Steel Casing and Screen
PVC = PVC Casing and Screen

NA = Not Applicable

CTC 001 0412

Four piezometers, identified as P-1, 1A, 2, and 2A, were constructed from 2-inch-diameter, schedule 80, PVC pipe. Well screens with a 0.010-inch slot size were used. Again, a "01" grade clean sand was used as a filter pack and the wells were sealed using commercial-grade bentonite pellets.

The unconsolidated sediment wells were developed using air surging and/or pumping techniques.

Water Level Monitoring

Upon completion, water levels were measured in the monitoring wells several times a week. In addition, continuous water level recorders were placed on bedrock monitoring wells MW-2, 3, 4, 5, 6, 8, 9, 10, and unconsolidated sediment wells MW-4A, 5A, and 6A to measure local pumping influences and monitor long-term water level fluctuations. Water level monitoring was initiated in March 1985 and continued through the completion of the pumping test in September 1985. Water level elevations are presented in Volume II of this report and in Appendix B.

Geophysical Logging

Borehole geophysical surveys were conducted upon completion of selected monitoring wells. This survey consisted of a natural gamma log that measured the natural radiation of gamma rays from the subsurface formations. The borehole geophysical logs are presented in Appendix B.

In-Situ Hydraulic Parameter Testing

In-situ hydraulic parameter testing was performed on selected bedrock and glacial sediment wells. These tests involved lowering the water level in the wells by pumping or bailing and measuring drawdown and/or recovery. Hydraulic conductivity was calculated for the glacial sediments. Transmissivity was calculated for both the glacial sediments and the bedrock wells. Test results and calculations are presented in Appendix B.

CTC 001 0413

Pumping Test

A pumping test was conducted after the completion and initial sampling of all monitoring wells. The objective of the test was to determine the potential for long-term pumping of a municipal well located near the site, to reverse the groundwater hydraulic gradient from the site to the well.

The pumping test was conducted using Fairfield Township Well No. 7. This well is located approximately 3,300 feet southwest of the Caldwell Trucking Company Site. On Figure 4-2, the Fairfield Municipal Well No. 7 is labeled as PW-7.

Twenty-five newly installed and existing monitoring wells were used as observation wells for this pumping test. Continuous water level recorders monitored water level fluctuations in 10 wells. The remaining 15 wells were measured using an M-scope and/or a chalked steel tape.

4.2 Site-Specific Geology

The geology at the Caldwell Trucking Company Site area, in general consists of glacial deposits of clay, silt, sand, gravel, and boulders overlying hard, black to gray-green basalt. The depth to top of bedrock ranges from approximately 3.0 to 75.0 feet below the ground surface. Figure 4-3 shows the locations of the generalized geologic cross-sections which are shown on Figures 4-4 and 4-5.

The unconsolidated sediments in the southern portion of the site property, described from test borings, consist mainly of sand and gravel or sand and silt mixtures. Boulders were encountered in one boring. These sediments range in thickness from 3 to 30 feet. In the northern portion of the site property, the unconsolidated material thicknesses increase to approximately 35 feet. The materials in this area consist mainly of sand, gravel, and boulders.

Unconsolidated sediments in the areas adjacent to the site again consist mainly of sand and gravel with varying amounts of fine grained sediments. Boulder zones

CTC 001 0414

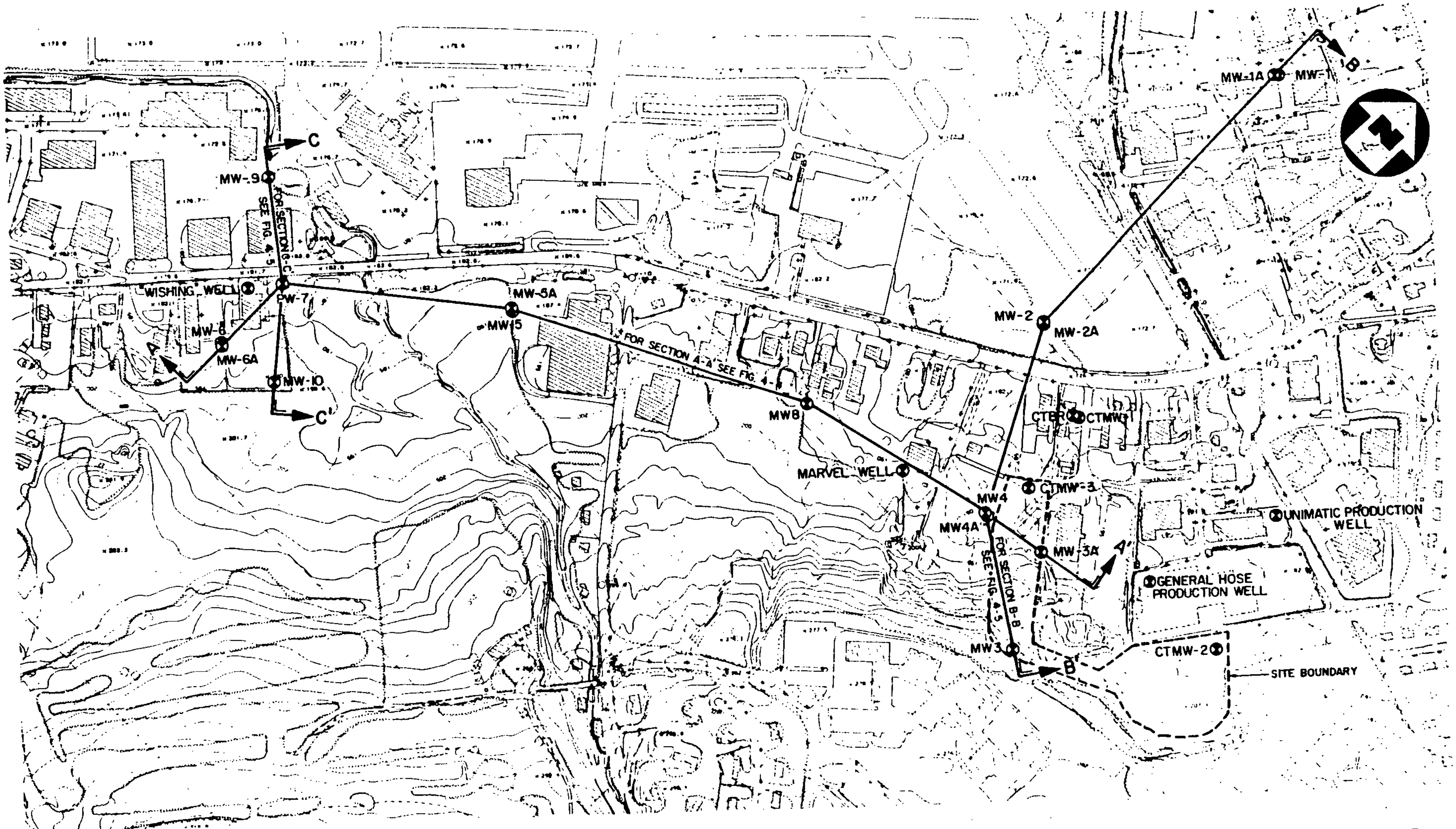

FIGURE 4-3

LOCATION OF WELLS AND CROSS SECTIONS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

CTC 001 0415

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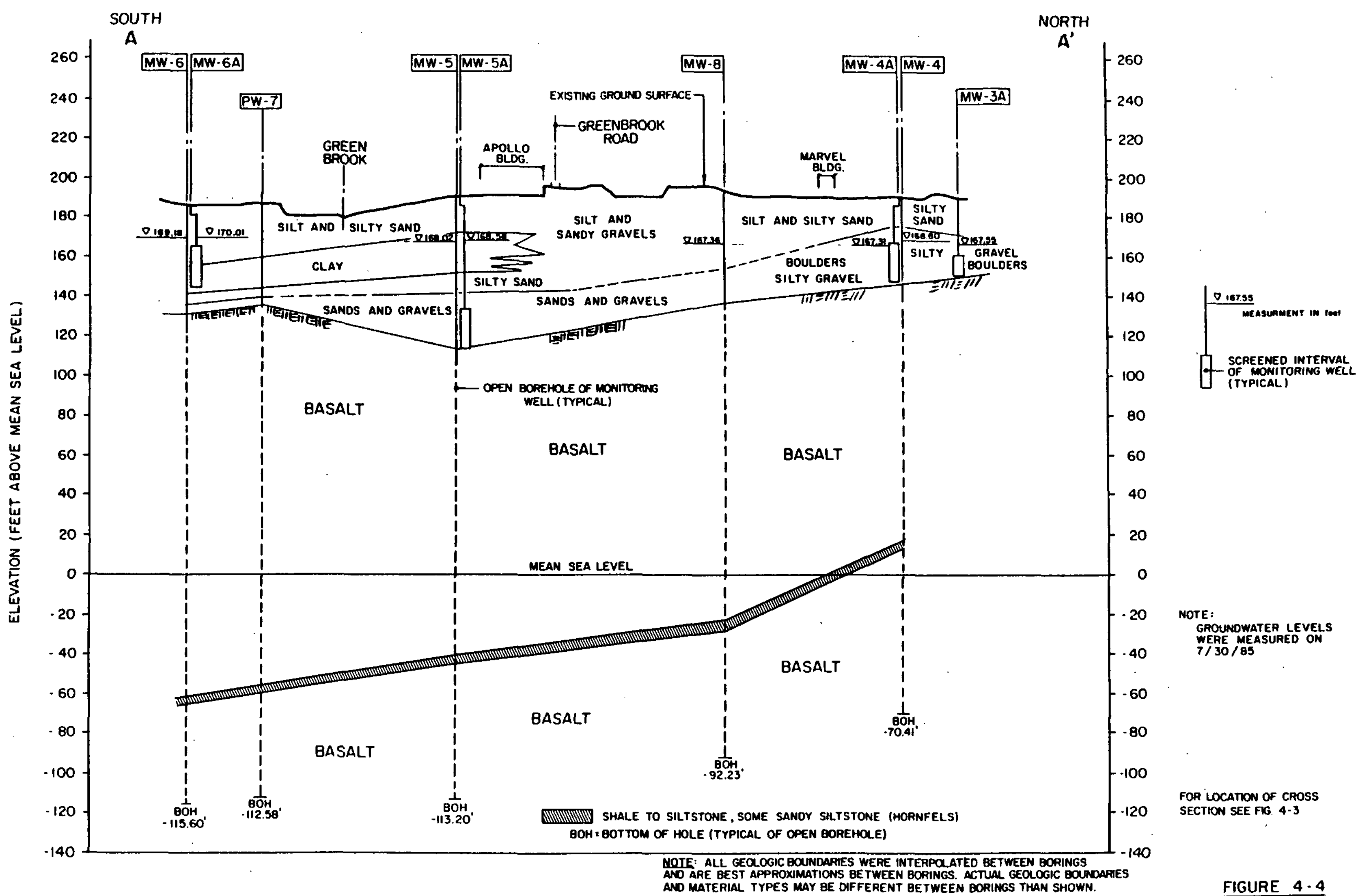

FIGURE 4-4

GENERALIZED GEOLOGIC CROSS SECTION A-A'
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ
SCALE: HORIZ. 1" = 500', VERT. 1" = 50'

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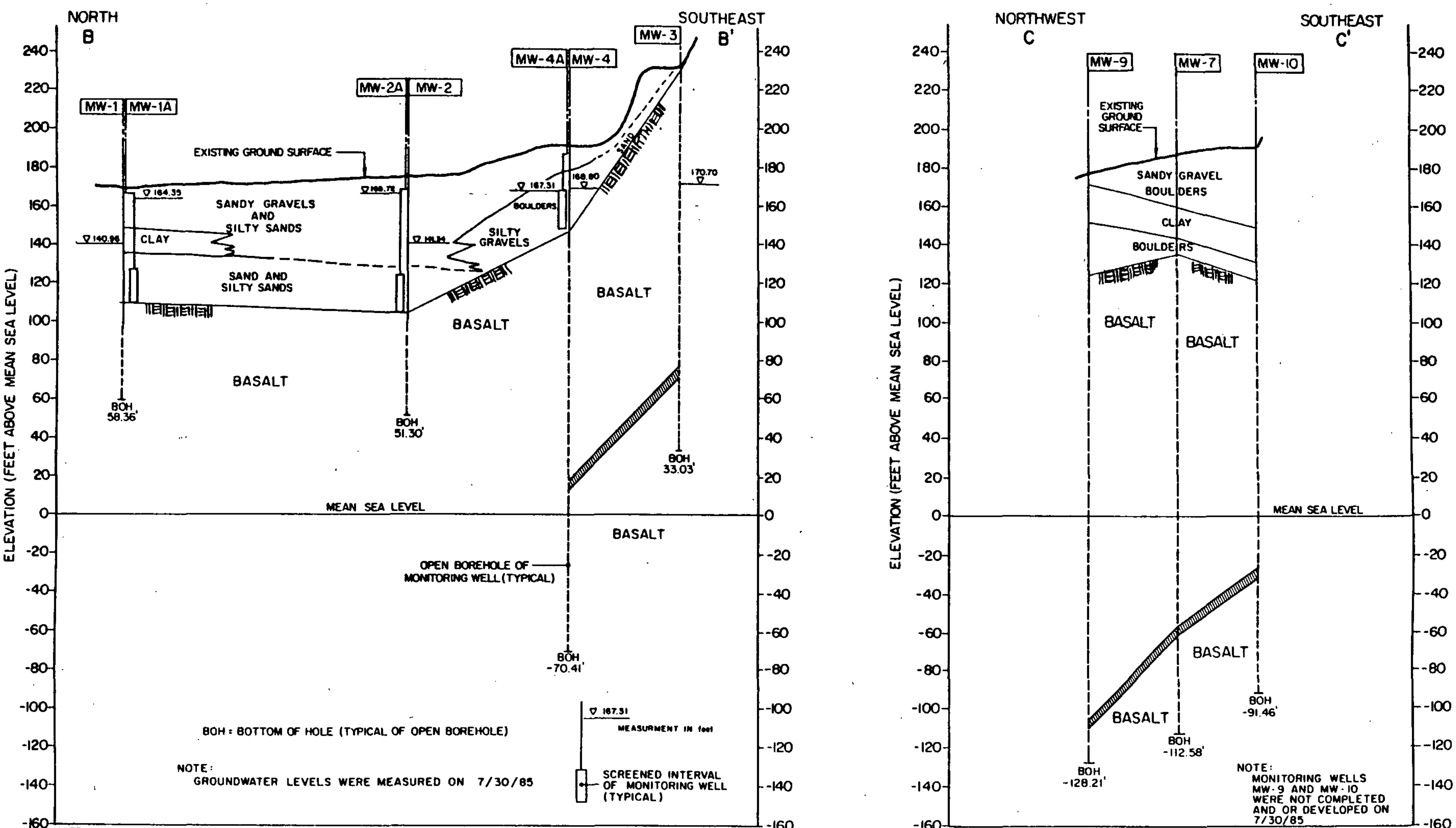

NOTE: ALL GEOLOGIC BOUNDARIES WERE INTERPOLATED BETWEEN BORINGS AND ARE BEST APPROXIMATIONS BETWEEN BORINGS. ACTUAL GEOLOGIC BOUNDARIES AND MATERIAL TYPES MAY BE DIFFERENT BETWEEN BORINGS THAN SHOWN.

FOR LOCATION OF CROSS SECTIONS SEE FIGURE 4-3

SHALE TO SILTSTONE, SOME SANDY SILTSTONE (HORNFELS)

FIGURE 4-5

GENERALIZED GEOLOGIC CROSS SECTIONS B-B' & C-C'
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ
SCALE: HORIZ. 1"=500', VERT. 1"=50'

CTC 001 0417

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were encountered during drilling in monitoring wells MW-1A, 3A, 4A, 9, and 10. A clay formation was described in the area around MW-7, south of the site.

Basalt bedrock occurs beneath the glacial deposits at and in the vicinity of the site.

The air drilling method made a detailed description of the bedrock using rock cuttings difficult. In general, the color of the basalt ranged from black to dark gray-green. Texture of the rock was predominantly fine grained, although coarser grained sections of rock were identified in some borings. Vesicular zones within the basalt were also encountered in some borings.

The structure of the basalt was predominantly massive, but fractured zones, identified by an increase in volume of water encountered during drilling, were identified.

Crystalline minerals were also observed within the basalt in some borings. These minerals included prehnite and other zeolites with carbonates.

In all deep bedrock wells, sedimentary rock zones were encountered between elevations +20 and -100 feet mean sea level (MSL). These zones ranged from 2 to 6 feet in thickness. The rock material in these zones ranged from shale to sandy siltstone. These areas were considered contact-metamorphic zones where the rock materials were baked to hornfels and/or granulite.

Using these hornfel zones, a dip of approximately 10° to the west was calculated for the bedrock units. This correlated well with the background general geologic information available for this area.

In the majority of the bedrock monitoring wells, the contact metamorphic zones, were considered to be highly fractured. These zones were consistently described as producing the greatest amount of water during drilling. One exception to this was in monitoring well MW-10, in which none of the bedrock zones produced significant amounts of water. No anomalies were identified in the drilling procedure or bedrock units for this well. The only difference was the lack of significant water producing zones. This indicates that there may be lateral variations in the fracture zones transmitting water in the project area. A gamma log was not run on MW-10.

Natural gamma logs were taken in borings MW-2, 3, 4, 5, 6, 8, and 9. Interpretation of these logs revealed only large-scale differences in sediments and bedrock encountered during the subsurface investigation. Glacial materials could be distinguished from the basalt bedrock, although these differences were generally not significant.

Within the glacial material section, zones which contained significant amounts of clay and silt could be identified and correlated well with boring logs produced from samples in the wells.

Within the bedrock, differences between the basalt and the hornfel zones were significant and easily detected. The basalt rock showed a consistent pattern with the gamma log. Changes within the basalt were difficult to see.

4.3 Groundwater Flow

Information gathered during this investigation indicates that both the glacial sediments and the bedrock are used as sources of water in this area.

The pumping test was conducted after the completion and initial sampling of all monitoring wells. The objective of the test was to determine the potential for long-term pumping of Municipal Well No. 7 (PW-7) located south of the site, to reverse the groundwater hydraulic gradients, in the glacial and the bedrock aquifers, from the site to the municipal well.

A detailed analysis of groundwater flucuations and the pumping test can be found in Volume II of this report. The major findings relating to groundwater flow, drawn from analysis of the pumping test are summarized in the following discussion.

CTC 001 0419

Glacial Sediment Aquifer

Wastes at the Caldwell Trucking Company Site were deposited in unlined lagoons constructed in the glacial sediments. Thus, these sediments act as an avenue for contaminant migration from the sources on the site to the glacial sediment aquifer that is hydraulically connected to the bedrock aquifer (see *Volume II* for hydraulic connection analysis).

Groundwater flow direction under what was considered static conditions (when Well No. 7 was not pumping and the Unimatic well was shutdown for two weeks) is north-northeast from the location of the pumping well PW-7 through the site toward the Passaic River. This gradient is depicted between the site and PW-7 in the generalized geologic cross-sections (Figures 4-4 and 4-5) by comparing the plotted groundwater elevations. Groundwater elevation information near the river (from P-1, 1A, 2, and 2A) indicates that some discharge to the river from the shallow groundwater system does occur. Detailed information concerning horizontal and vertical gradients for the sediments near the river, can be found in Volume II of this report.

Figures 4-6 through 4-9 are groundwater elevation contour maps for different periods of time during the large-scale pumping test of PW-7. These periods were chosen to analyze and discuss nonpumping and pumping-induced flow patterns in the glacial aquifer. Continuous water level records, hydrographs, and water level elevations used to generate these water contour maps can be found in Volume II and Appendix B of this report.

Figure 4-6 depicts the groundwater flow direction under nonpumping conditions when Well No. 7 was not pumping and the Unimatic well was not in use, over a weekend. The groundwater flow in general is northeast from the location of Well No. 7 (PW-7) toward the site.

Figure 4-7 shows groundwater flow direction in the glacial aquifer when the Unimatic well was pumping alone. Groundwater elevation changes show that

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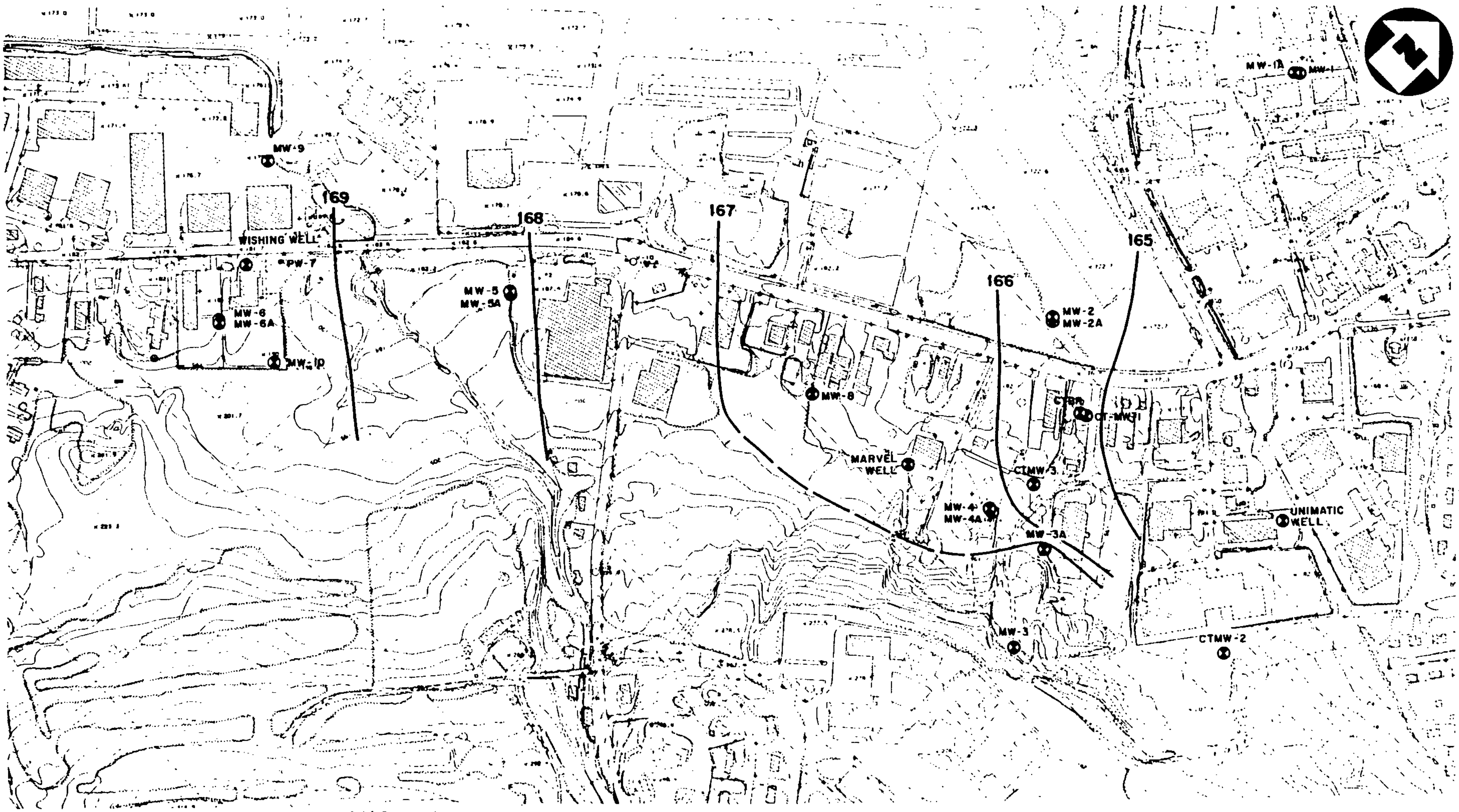

NOTE: GROUNDWATER ELEVATIONS WERE MEASURED ON 8/18/85 AT 1450 hrs

FIGURE 4-6

GROUNDWATER CONTOURS IN THE GLACIAL AQUIFER UNDER NON-PUMPING CONDITIONS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

400 0 400
SCALE IN FEET

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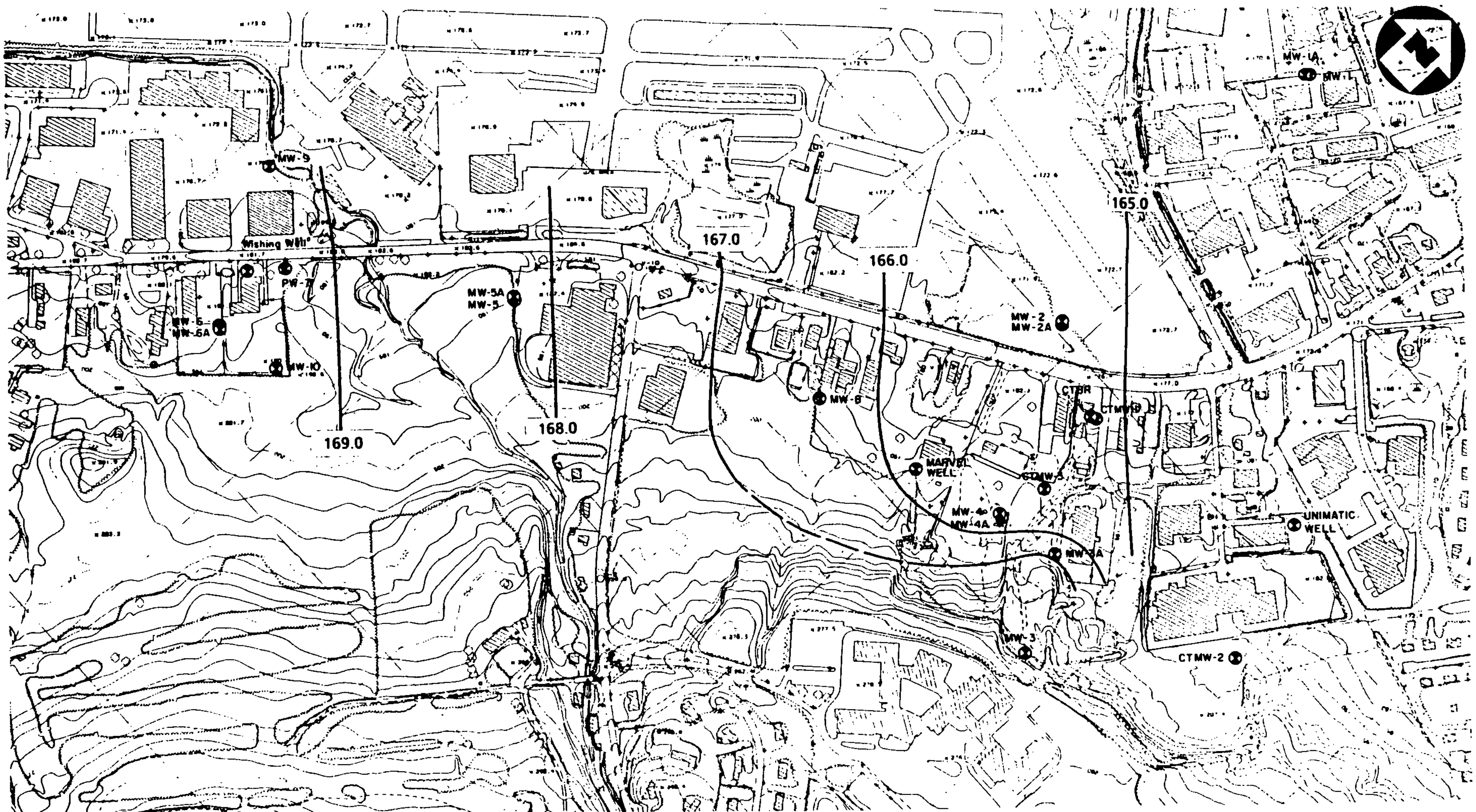
CTC 001 0421



NOTE: GROUNDWATER ELEVATIONS WERE MEASURED ON 8/15/85 AT 1600 hrs

FIGURE 4-7

GROUNDWATER CONTOURS IN THE GLACIAL AQUIFER WITH THE UNIMATIC WELL PUMPING
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

400 0 400
SCALE IN FEET

NUS CORPORATION
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CTC 001 0422

NOTE: GROUNDWATER ELEVATIONS WERE MEASURED ON 8/25/85 AT 1500 hrs

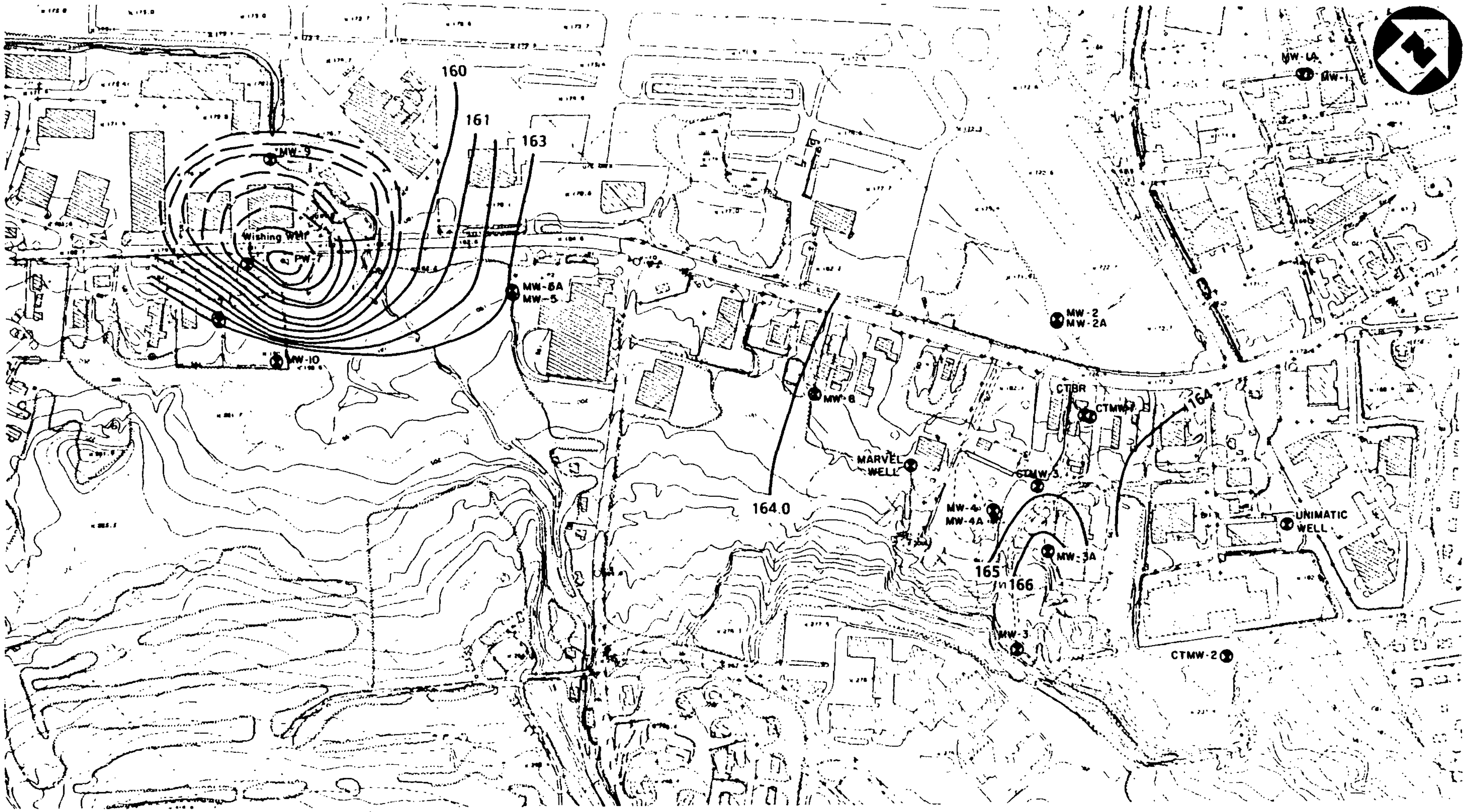
FIGURE 4-8

GROUNDWATER CONTOURS IN THE GLACIAL AQUIFER WITH PW-7 PUMPING
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

400 0 400
SCALE IN FEET

NUS CORPORATION
A Halliburton Company

CTC 001 0423



NOTE: GROUNDWATER ELEVATIONS WERE MEASURED ON 8/23/85 AT 1600 hrs

FIGURE 4-9

GROUNDWATER CONTOURS IN THE GLACIAL AQUIFER WITH THE UNIMATIC WELL AND PW-7 PUMPING
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

400 0 400
SCALE IN FEET

NUS CORPORATION
A Halliburton Company

groundwater flow again is north from Well No. 7 (PW-7) toward the project site and the Unimatic well.

Figure 4-8 depicts the groundwater flow in the glacial aquifer when Well No. 7 (PW-7) was pumping alone. Analyses of the groundwater elevations in this figure shows shallow groundwater flow direction to be from portions of the site to Well No. 7. The cone of depression depicted at PW-7 was estimated using distance drawdown information from well MW-5A and 6A.

Figure 4-9 shows the groundwater flow in the glacial aquifer when the Unimatic well and Well No. 7 were both pumping. A groundwater divide is located in the glacial aquifer flow system in the vicinity of the site. This figure shows a potential for shallow groundwater flow from portions of the site toward Well No. 7.

Bedrock Aquifer

The bedrock groundwater system transmits water through fractured zones in the basalt bedrock. Water levels taken in open-borehole wells may represent composite water levels of the different fractured zones encountered. Analyses of hydrogeologic information indicated that water levels measured in bedrock wells that encountered the major hornfels zone discussed previously were more representative of that fractured zone rather than a composite of all the fractured zones. Therefore, it was felt that these water levels could be contoured to determine groundwater flow direction.

Selected bedrock wells were not used to generate the contour maps. Monitoring well MW-10 was excluded even though the hornfels zone was encountered during drilling. Low water production from this well and a significantly higher groundwater elevation indicated that this well could not be correlated and used in conjunction with other deep bedrock wells. Monitoring wells MW-1 and 2 were shallow bedrock wells that did not intercept the hornfels zone. Significantly lower

CTC 001 0425

groundwater elevations in these wells indicated that, again, these wells could not be correlated and used with the other bedrock wells for determination of flow direction.

Groundwater flow direction in the bedrock aquifer under static conditions is also northeast from the location of pumping well PW-7 to the site. Again, this can be seen by comparing the plotted groundwater elevations for bedrock wells in the generalized geologic cross-sections (Figures 4-4 and 4-5). It should be noted that under static conditions water level elevations of deep bedrock wells MW-4 and 3 are higher than adjacent glacial sediment wells, which indicates an upward hydraulic gradient in this area. Figures 4-10 through 4-13 are bedrock groundwater elevation contour maps for the same periods of time as the glacial aquifer contour maps.

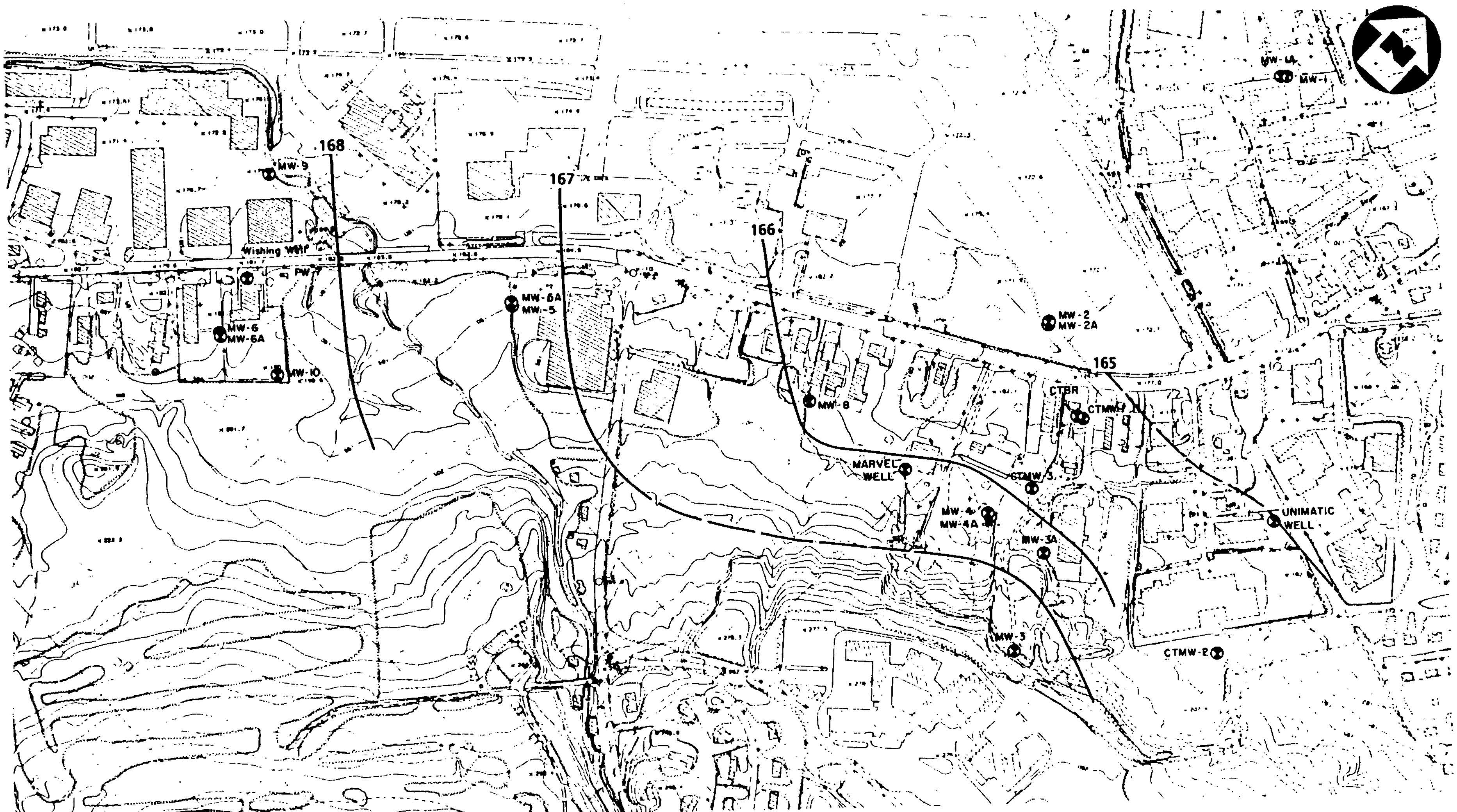
Figure 4-10 depicts groundwater contours under nonpumping conditions. In this figure, groundwater flow is north-northeast from Well No. 7 (PW-7) toward the project site.

Figure 4-11 shows the groundwater contours when the Unimatic well was pumping alone. Drawdown measurements were predicted at the Unimatic well using a distance drawdown curve generated from the effect of Unimatic pumping on monitoring wells MW-3, 4, 8, and 5. A comparison of the water level elevations shows that the groundwater flow direction in general is northeast from Well No. 7 (PW-7) toward the site and the Unimatic well.

Figure 4-12 shows the groundwater contours in the bedrock aquifer with Well No. 7 (PW-7) pumping alone. The flow direction is west-southwest from portions of the site toward PW-7.

When Unimatic and Well No. 7 were pumping together, as shown on Figure 4-13, the groundwater flow direction near the project site was difficult to predict. This figure shows a groundwater elevation high point (divide) very close to a portion of the Caldwell Trucking Company Site. In this case, where both wells were pumping,

CTC 001 0426



NOTE: GROUNDWATER ELEVATIONS WERE MEASURED ON 8/18/85 AT 1450 hrs

FIGURE 4-10

GROUNDWATER CONTOURS IN THE DEEP BEDROCK AQUIFER UNDER NON-PUMPING CONDITIONS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

400 0 400
SCALE IN FEET

NUS CORPORATION
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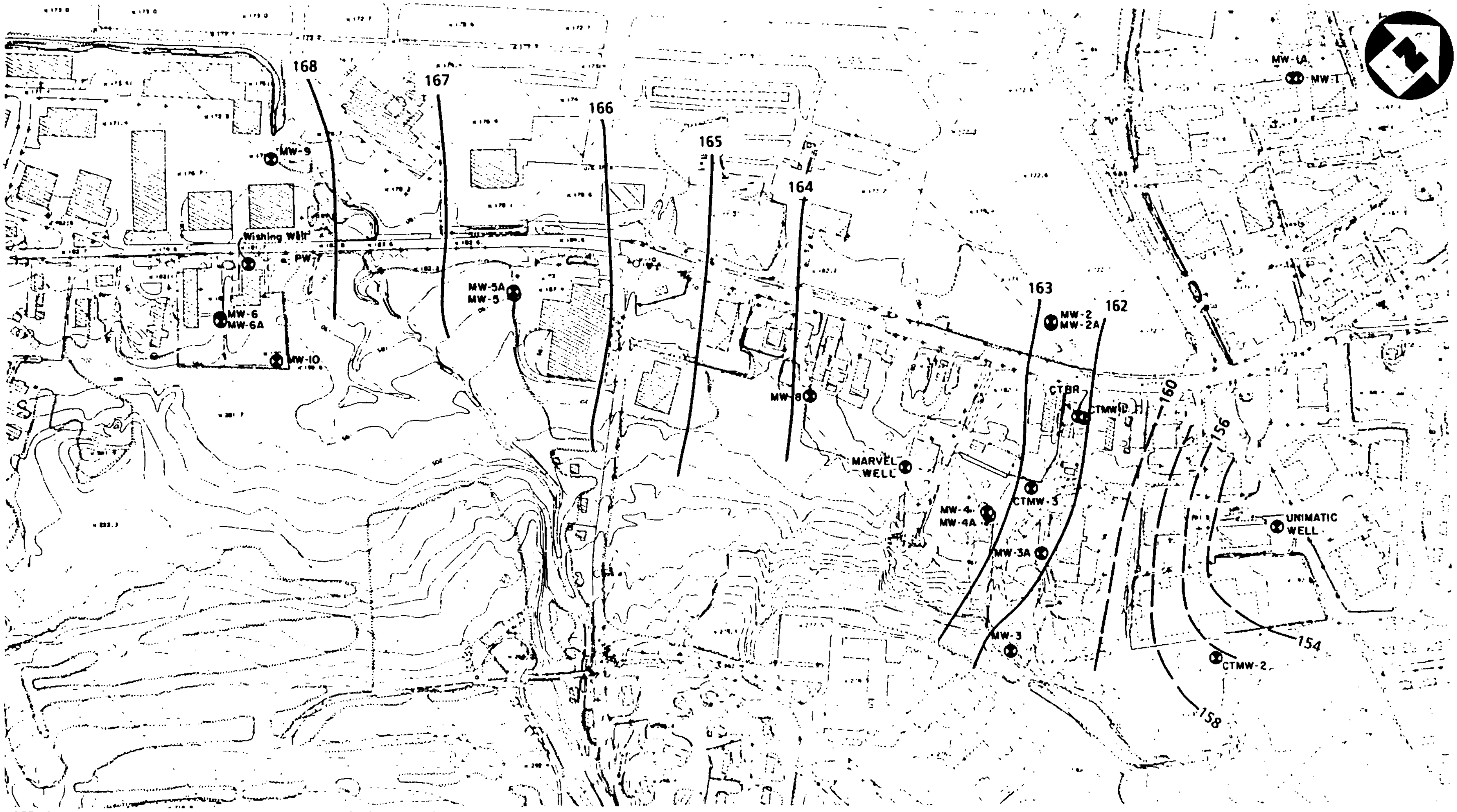
CTC 001 0427



NOTE: GROUNDWATER ELEVATIONS WERE MEASURED ON 8/15/85 AT 1600 hrs

FIGURE 4-11

GROUNDWATER CONTOURS IN THE DEEP BEDROCK AQUIFER WITH THE UNIMATIC WELL PUMPING
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

400 0 400
SCALE IN FEET

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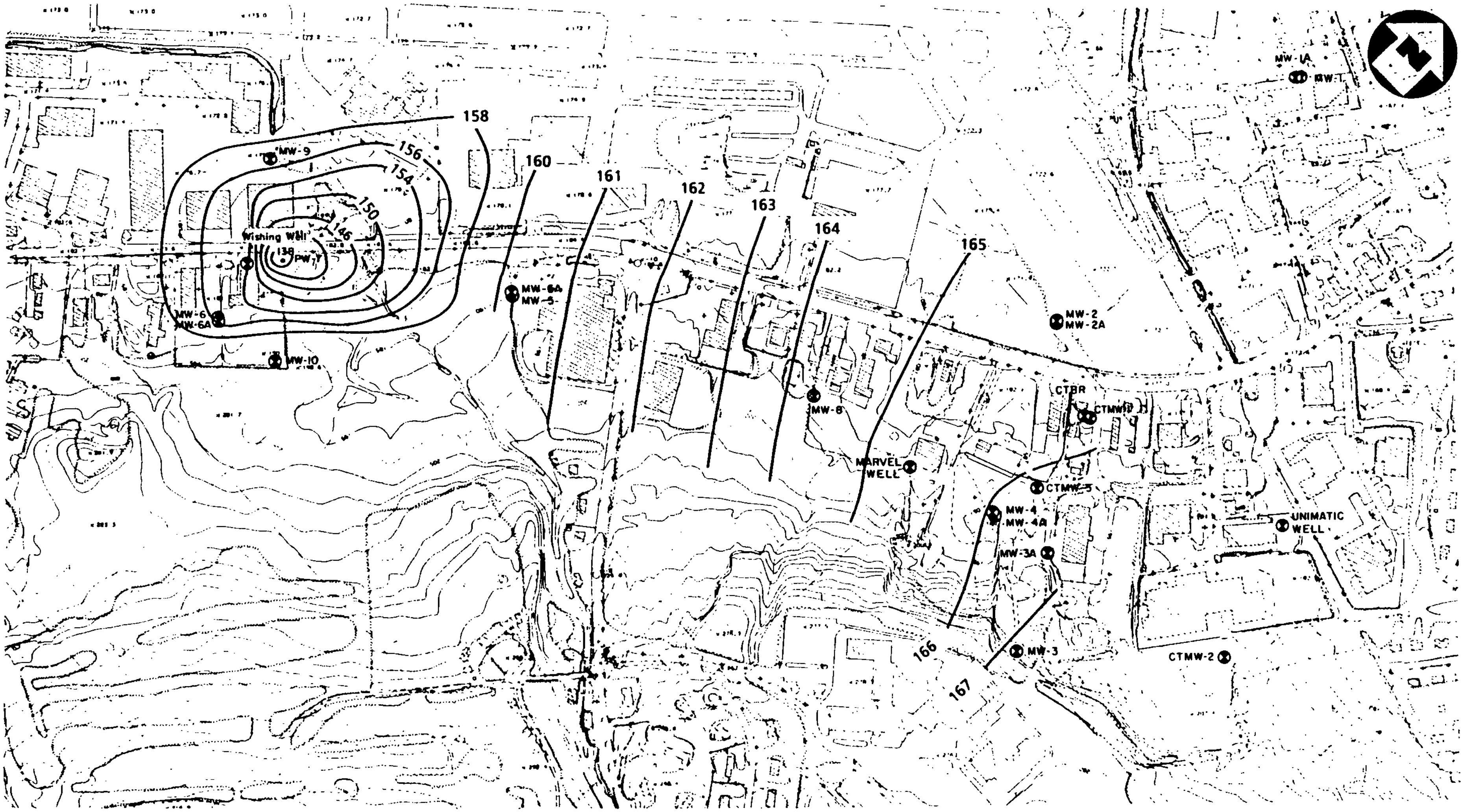

NOTE: GROUNDWATER ELEVATIONS WERE MEASURED ON 8/25/85 AT 1500 hrs

FIGURE 4-12

GROUNDWATER CONTOURS IN THE DEEP BEDROCK AQUIFER WITH PW-7 PUMPING
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

400 0 400
SCALE IN FEET

NUS CORPORATION
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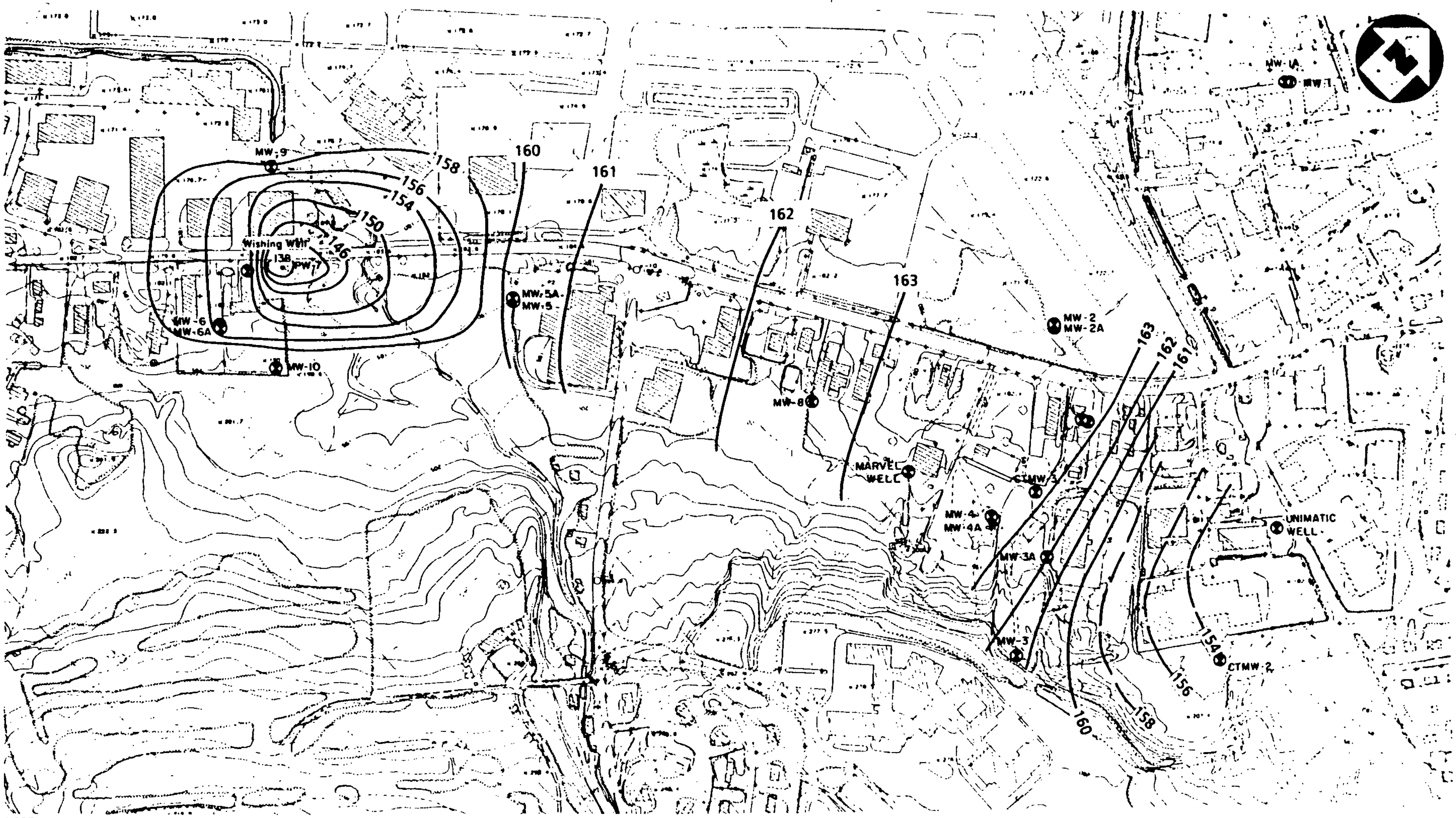
CTC 001 0429



NOTE: GROUNDWATER ELEVATIONS WERE MEASURED ON 8/23/85 AT 1600 hrs

FIGURE 4-13

GROUNDWATER CONTOURS IN THE DEEP BEDROCK AQUIFER WITH THE UNIMATIC WELL AND PW-7 PUMPING
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

400 0 400
SCALE IN FEET

NUS CORPORATION
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CTC 001 0430

there is a potential for bedrock groundwater to flow from portions of the site to Well No. 7. This potential will increase if the pumping rate of Well No. 7 was increased and/or the pumping rate of the Unimatic well was decreased, thus altering the location of the groundwater divide closer to the site. The opposite would be true if the pumping rate at PW-7 was decreased and/or the rate at Unimatic was increased.

Groundwater flow direction will be influenced by other wells pumping in the vicinity of the project site. Although not shown in any of the Bedrock Aquifer Contour Maps, the daily short-term pumping at the Marvel well will influence bedrock groundwater flow near this well. Water level records show that there are significant drawdowns in this well when the pump turns on (see Figure 11 in Volume II of this report). During periods of well use, bedrock groundwater elevations near this well will be lowered. Full recovery between consecutive drawdowns does not occur when the well is in use. This will create a low point in the bedrock flow system in the area of this well. This low point may inhibit bedrock groundwater flow from the site, past the Marvel well to Well No. 7 when Well No. 7 is pumping. This same type of Marvel well influence may occur in the hydraulically connected glacial sediments.

During static conditions and certain pumping induced groundwater flow conditions (Figures 4-8 and 4-12, PW-7 pumping alone), there is an upward hydraulic gradient from the deep bedrock to glacial aquifer at the project site. This is indicated by higher water elevations in deep bedrock wells MW-3 and 4, nearer the site than in the adjacent glacial sediment-wells. However the hydraulic gradient reverses moving south away from the site. This upward hydraulic gradient may inhibit contamination of the deep bedrock fracture zones by the shallow bedrock fracture zones and by the glacial aquifer directly beneath the site.

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4.4 Groundwater Quality

4.4.1 Sampling and Analysis

Seven existing and 19 newly installed monitoring wells were sampled twice in this study, once before the pumping test and once after the pumping test. The primary objectives of this sampling were to characterize the water quality upgradient of the site, to confirm previous results from existing wells, to investigate any differences in water quality between the glacial aquifer and the bedrock aquifer, and to check for any apparent migration of contamination upgradient from the site toward Municipal Well No. 7 during the pumping test.

Seven residential wells were sampled one time to provide information on contamination in the plume area to supplement existing data provided by the New Jersey Department of Environmental Protection (NJDEP).

The locations of all the groundwater sampling points are shown in Figure 4-14. All samples were analyzed for HSL organic and inorganic compounds as well as water quality and contamination indicator parameters. Analytical results are provided in Appendix B.

4.4.2 Extent of Contamination

Several organic and inorganic HSL compounds were detected in groundwater samples collected from wells both on and off the Caldwell Trucking Company Site. Table 4-2 shows the occurrence of the various contaminants in groundwater samples and illustrates that the primary contamination is due to volatile organic compounds. Within this group, chlorinated aliphatics constitute the largest proportion and widest occurrence. Of these compounds, trichloroethylene was detected in the highest concentrations (up to 20,000 µg/l) and the most often (73 percent of the samples). The next most frequently detected compounds were 1,1,1-trichloroethene (47 percent), trans-1,2-dichloroethene (46 percent), chloro-

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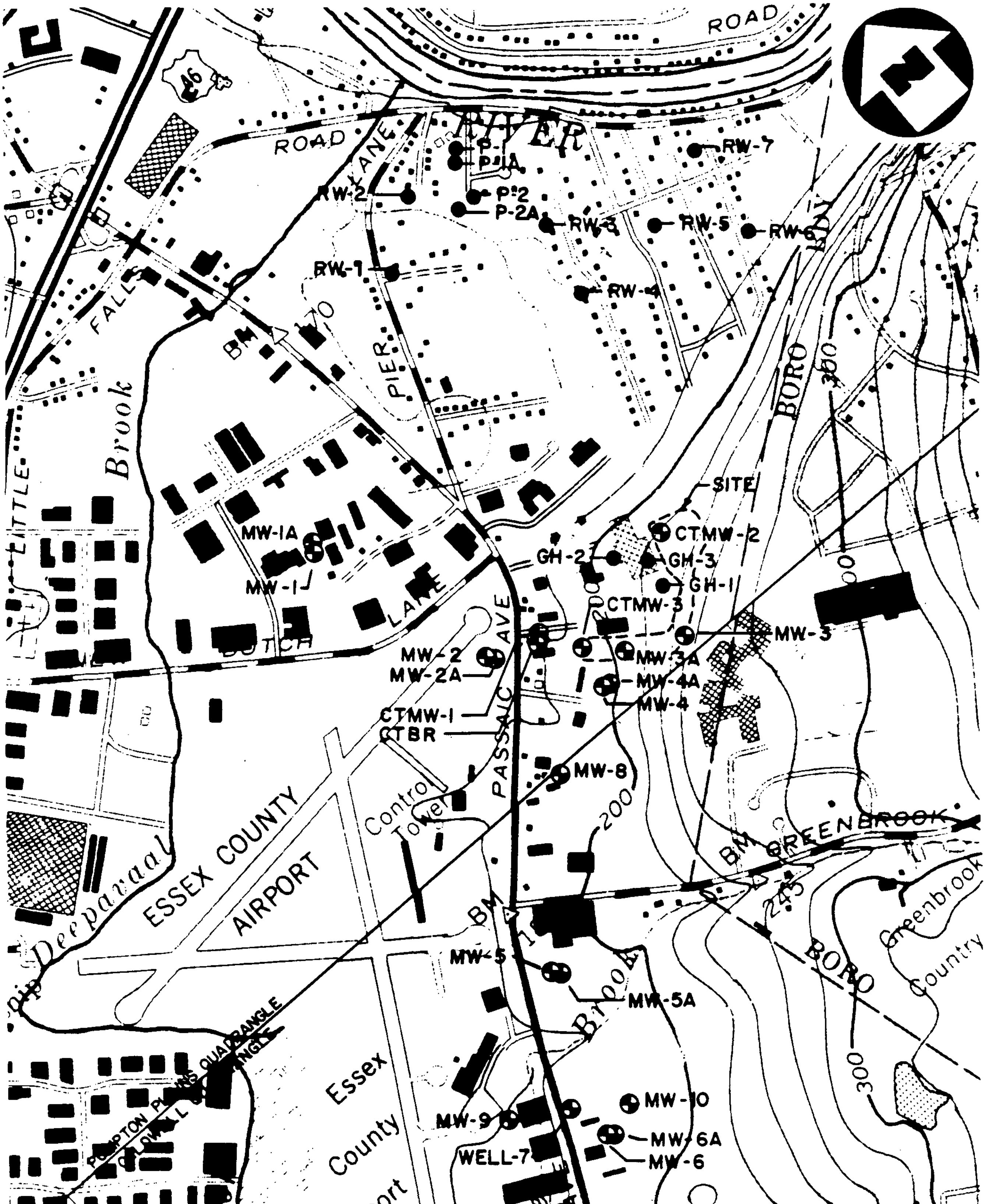

BASE MAP IS AN ENLARGEMENT OF A PORTION OF FIGURE 2-1.

FIGURE 4-14

GROUNDWATER SAMPLING LOCATIONS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

SCALE: 1" = 1000'

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TABLE 4-2

SUMMARY OF GROUNDWATER CONTAMINATION FOUND IN THIS INVESTIGATION CALDWELL TRUCKING COMPANY SITE

			Monitoring Wells		Residential Wells	
PP #	CAS #	Contaminant	Concentration Range (µg/l)	Number of Occurrences	Concentration Range (µg/l)	Number of Occurrences
44V	75-09-2	Methylene Chloride	130 - 13,000	8/52	180 - 12,500	2/7
29V	75-35-4	1,1-Dichloroethene	5 - 560	16/52	397 - 400	2/7
10V	75-34-3	1,1-Dichloroethane	1 - 1,100	17/52	140 - 150	2/7
30V	156-60-5	Trans-1,2-Dichloroethene	1 - 12,000	26/52	1,200 - 1,500	2/7
23V	67-66-3	Chloroform	1.9 - 4,400	21/52	3,160 - 3,600	2/7
11V	71-55-6	1,1,1-Trichloroethane	3.8 - 9,600	26/52	1,915 - 3,500	2/7
87V	79-01-6	Trichloroethene	4.1 - 36,000	36/52	7.4 - 14,000	4/7
85V	127-18-4	Tetrachloroethene	1 - 3,000	22/52	380	2/7
88V	75-01-4	Vinyl Chloride	110 - 4,900	4/52	ND	
16V	75-00-3	Chloroethane	110	1/52	ND	
14V	71-43-4	Benzene	14 - 16	2/52	22 - 40	2/7
86V	108-88-3	Toluene	1.4 - 65	3/52	ND	
65A	108-95-2	Phenol	10	8/52	ND	
26B	543-73-1	1,3-Dichlorobenzene	10 - 20	2/52	ND	
27B	106-46-7	1,4-Dichlorobenzene	19 - 43	3/52	ND	
25B	95-50-1	1,2-Dichlorobenzen	15 - 270	3/52	ND	
7V	108-90-7	Chlorobenzene	2.5 - 3.6	2/52	ND	
8B	120-82-1	1,2,4-Trichlorobenzene	2	1/52	ND	
NP	67-64-1	Acetone	11,000 - 110,000	3/52	410	1/7
NP	78-93-3	2-Butanone	5.9 - 6.3	2/52	ND	
NP	591-78-6	2-Hexanone	5 - 93	2/52	ND	
NP	108-10-1	4-methyl-2-pentanone	64	1/52	ND	
70B	117-84-0	Diethylphthalate	1	2/52	ND	ND
69B	84-66-2	Di-n-Octylphthalate	20	1/52	ND	
66B	117-84-0	Bis(2-ethylhexyl)phthalate	6 - 2,000	13/52	ND	
1B	83-32-9	Acenaphthene	1 - 2	2/52	ND	
73B	50-32-8	Benzo(a)pyrene	2.7 - 8	2/52	ND	
79B	191-24-2	Benzo(g,h,i)perylene	3.1	1/52	ND	
74B	205-99-2	Benzo(b)fluoranthene	3.3	1/52	ND	
75B	207-08-9	Benzo(k)fluoranthene	3.3	1/52	ND	

TABLE 4-2
SUMMARY OF GROUNDWATER CONTAMINATION FOUND IN THIS INVESTIGATION
CALDWELL TRUCKING COMPANY SITE
PAGE TWO

			Monitoring Wells		Residential Wells	
PP #	CAS #	Contaminant	Concentration Range (µg/l)	Number of Occurrences	Concentration Range (µg/l)	Number of Occurrences
103P	319-85-7	Beta BHC	0.01	1/52	ND	
106P	53469-21-9	Arochlor 1242	40	1/52	ND	
107P	11097-69-1	Arochlor 1254	4.5	1/52	ND	
97P	1031-07-8	Endosulfan sulfate	ND		0.17	1/7
95P	959-98-8	Endosulfan I	0.01	1/52	ND	
NP	75-15-0	Carbon disulfide	500	1/52	ND	
NP	100-51-6	Benzyl alcohol	20	1/52	ND	
6V	56-23-5	Carbon tetrachloride	5-44	3/52	ND	
		Total xylenes	5 - 35	3/52	ND	

Notes:

NP = Non-Priority Pollutant
ND = Not Detected

form (40 percent), tetrachloroethene (35 percent), 1,1-dichloroethene (32 percent) and 1,1-dichloroethane (27 percent). Several other organics were detected in 2 to 19 percent of the samples and at relatively low concentrations (two to four orders of magnitude lower), except for acetone (maximum concentration 110,000 µg/l), bis(2-ethylhexyl)phthalate (maximum concentration 2,000 µg/l), methylene chloride (maximum concentration 13,000 µg/l), and vinyl chloride (maximum concentration 1,200 µg/l).

The volatile organic compounds noted above, in addition to being the most frequently detected compounds, are also the most mobile in the subsurface environment. Therefore, for the purposes of this discussion, their distribution is considered indicative of the extent of groundwater contamination. For convenience, they will be discussed as total volatile organics (TVO) computed as the sum of the individual compound's concentration in each sample.

Wells exhibiting the highest TVO concentrations are located to the northeast of the Caldwell Trucking Company Site in the downgradient direction of regional groundwater flow. Historical data provided by the NJDEP defined a volatile organics contaminant plume originating at the site and extending northeast to the Passaic River. Monitoring wells MW-3A, GH-2 and 3, P-1 and 2, and residential wells RW-1 and 2 are located within this plume area and exhibit the highest concentrations of volatiles.

Wells located to the northwest and southeast of the plume area (MW-1, 1A, 2, and 2A, and RW-3 through 7) show much lower levels of TVOs. Based on these results, and the previously mentioned NJDEP interpretation of the plume, the approximate width of the plume is 2,500 feet with a length of approximately 4,250 feet. The thickness of the plume beyond the deepest monitoring well cannot be accurately determined without additional wells drilled beyond that point.

Other wells to the west and northwest, on the perimeter of the site, including MW-4, 4A, and 2, CTMW-1 and 3, and especially CT-BR, also exhibit high concentrations of volatiles. These wells are not directly downgradient of the suspected source areas on the site. Instead, the contamination of these wells is thought to be indicative of local pumping influences (see Section 4.3) and variable hydrogeologic properties discussed in detail in Section 8.3.

Volatiles were detected in the monitoring wells farthest southwest of the site (MW-6, 6A, and 9) at concentrations as high as 256 µg/l (MW-6A) and in the municipal well (PW-7) at 1,632 µg/l. These wells are located approximately 3,000 feet southwest (upgradient) of the site. However, as indicated in Section 4.3, pumping of the municipal well (PW-7) exhibits the potential for reversing the hydraulic gradient in both the glacial materials and in the fractured basalt from the site toward the municipal well. On the other hand, bedrock wells MW-8 and 5, and shallow well MW-5A, located between the site and the contaminated upgradient wells, exhibit no volatile contamination above the detection limits before and after the pumping test. This fact makes it doubtful that the contamination in this area is related only to the sources at the Caldwell Trucking Company Site. This issue will be addressed in greater detail in Section 7.0. The extent of groundwater contamination detected in this study is shown in Figure 4-15.

4.5 Soils

4.5.1 Sampling and Analysis

The objectives of the soil sampling program were to investigate lithology in the glacial material, to delineate the horizontal and vertical extent of contamination in the former lagoon areas, and to indicate areas of surface soil contamination. Subsurface soil samples were collected from soil borings on site and from monitoring well borings around the site. Surface soil and sediment samples were collected on site and from areas receiving surface drainage from the site. The sampling locations are shown in Figures 4-16 and 4-17.

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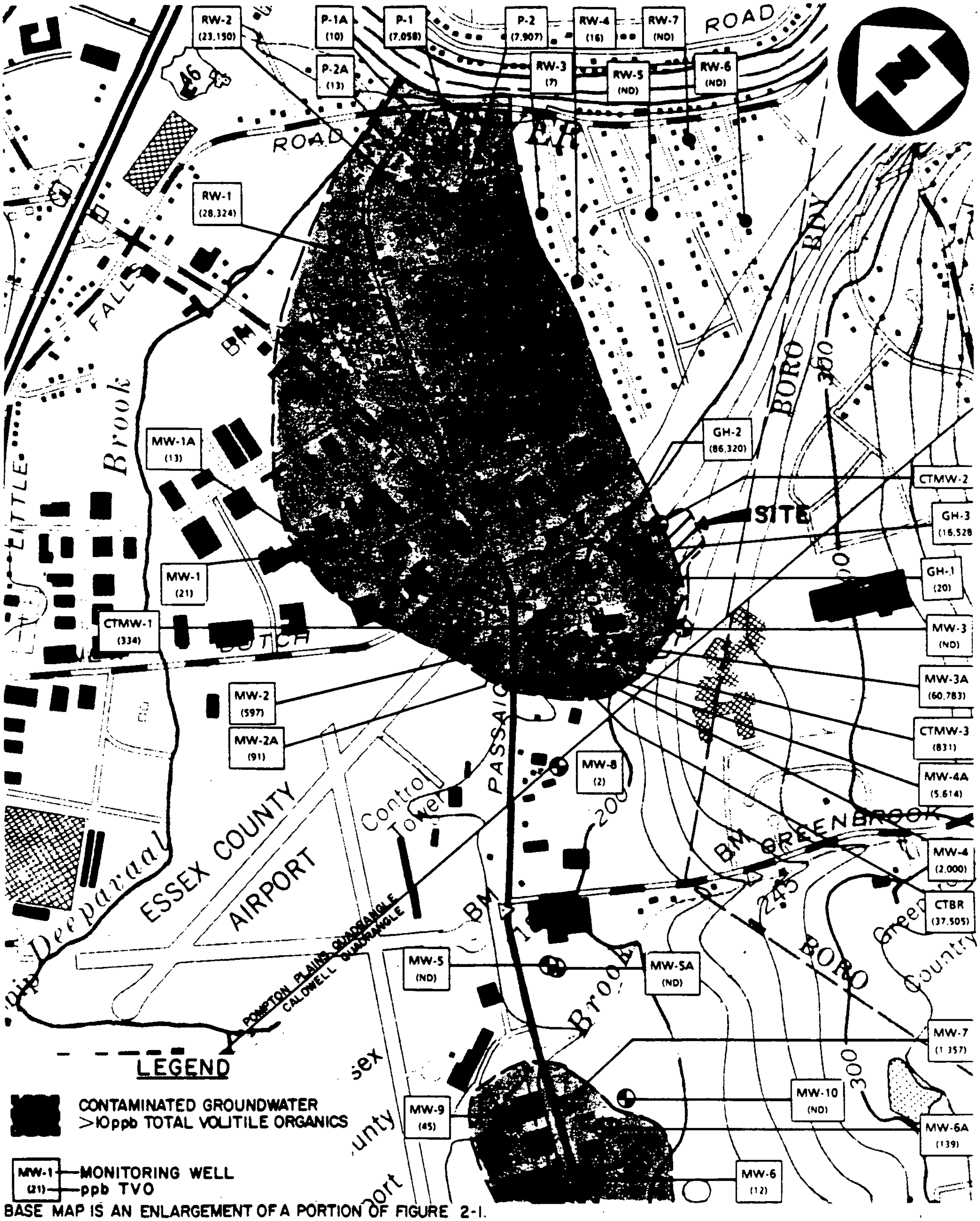

FIGURE 4-15

EXTENT OF CONTAMINATION IN GROUNDWATER
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

SCALE: 1" = 1000'

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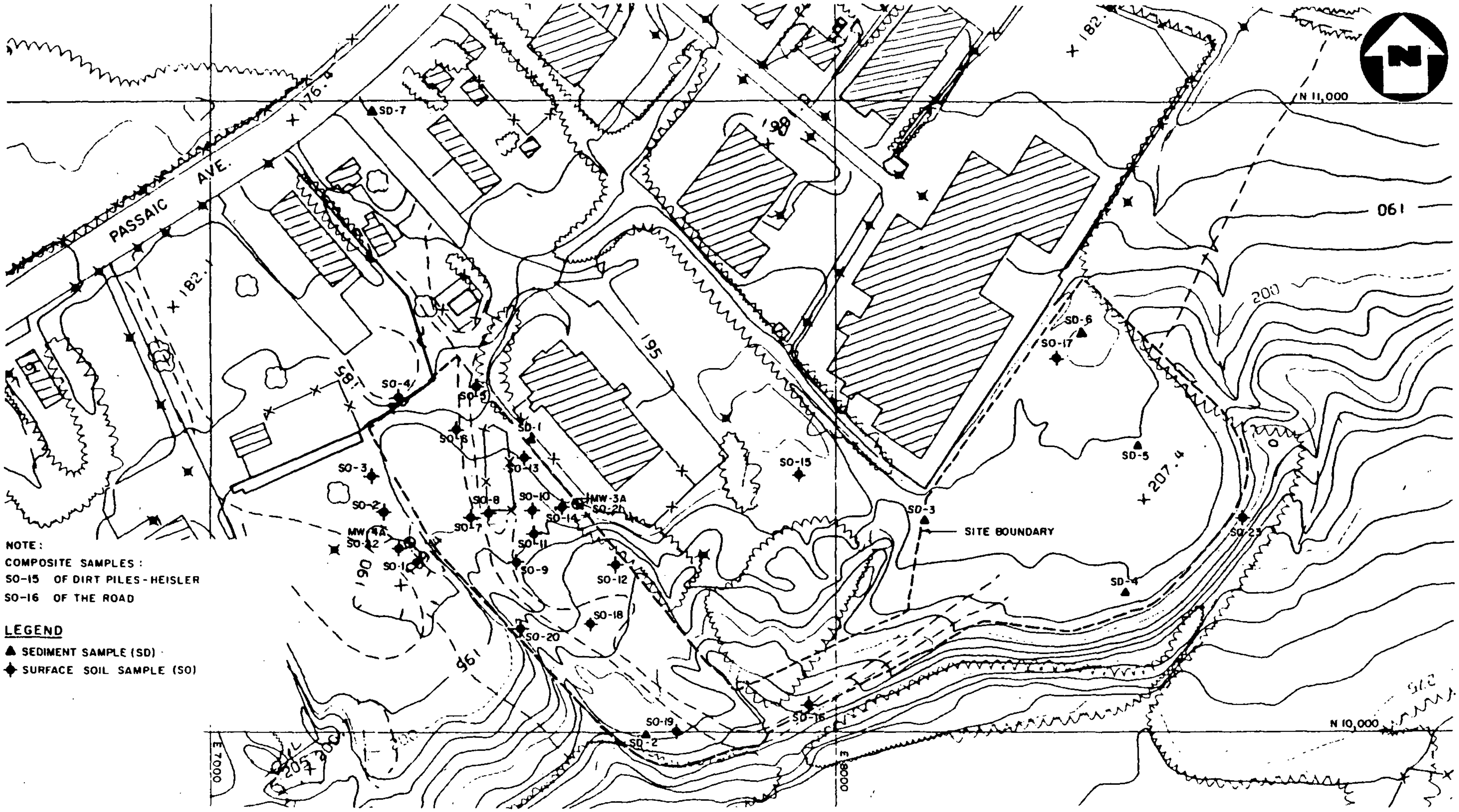

FIGURE 4-16

SURFACE SOIL/SEDIMENT SAMPLING LOCATIONS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

150 0 150
SCALE IN FEET

NUS CORPORATION
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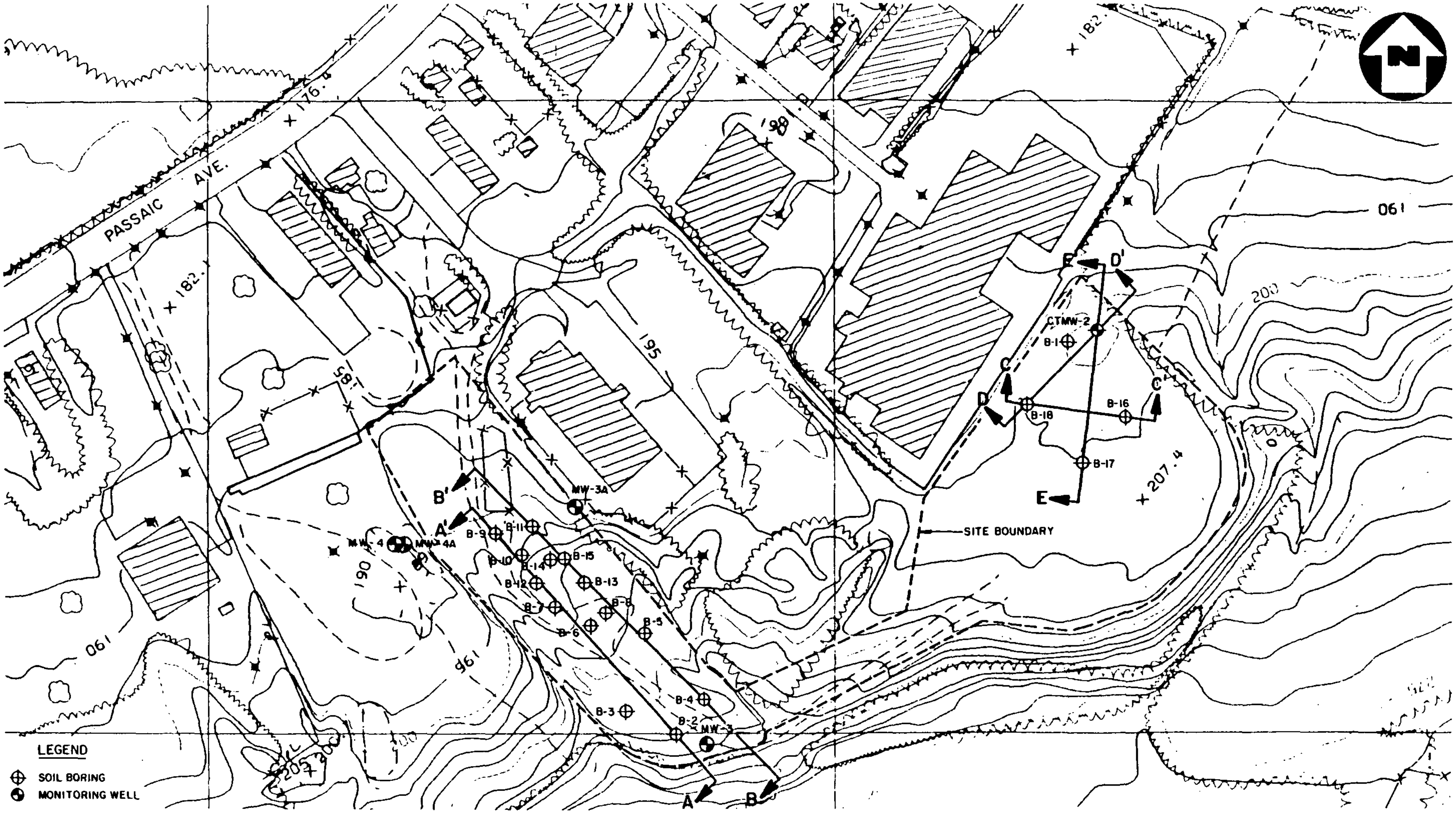

FIGURE 4-17

SUBSURFACE SOIL SAMPLING LOCATIONS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

NUS CORPORATION
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CTC 001 0440

4.5.1.1 Subsurface Soil Sampling

Onsite soil borings B-1 through B-18 were sampled using a cable tool drilling rig and split spoon sampler. Samples were obtained continuously from the ground surface to bedrock whenever possible. Sampling depths ranged from 0 to 35 feet below ground surface. However, poor sample recovery and the presence of boulder zones made sampling very difficult. Therefore, far fewer samples than desired were actually taken. The same problem limited the number of soil samples obtained from the monitoring well borings. Samples from these borings were obtained from locations MW-1A, 2A, 3A, and 4A.

All subsurface soil samples were screened in the field using organic vapor meter headspace testing as outlined in the Site Operations Plan. These results were used to choose samples for laboratory analysis. Samples with the highest headspace organic vapor readings, and some with no readings, were analyzed for HSL organic and inorganic compounds. As a result, 100 samples were taken from soil and monitoring well borings and only 58 were actually analyzed. The results are presented in Appendix B.

4.5.1.2 Surface Soil/Sediment Sampling

Twenty-seven surface soil/sediment samples were collected from the locations shown in Figure 4-16. These sample locations were selected based upon organic vapor meter in-situ soil gas analysis performed over the entire site area. Locations where the analysis indicated organic vapors in the soils were subsequently sampled and analyzed for HSL organics, inorganics, and total organic carbon (TOC). A background location (SO-20) and areas where low or no organic vapor readings were detected were also sampled.

At the time of sampling, all 27 samples were screened in the field using a gas chromatograph for volatile organics and polychlorinated biphenyls (PCBs). This was performed to provide quick turnaround of these results to allow data reduction and analysis to begin in advance of the availability of laboratory results. The

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results agree with the laboratory analysis and are provided, along with the laboratory results, in Appendix B.

4.5.2 Extent of Contamination

4.5.2.1 Surface Soils

Table 4-3 summarizes the contamination detected in surface soils on and in the vicinity of the Caldwell Trucking Company Site. The predominant surface soil contaminants are PCBs and polynuclear aromatic hydrocarbons (PAHs). Other contaminants include organic chemicals from several classes including chlorinated aliphatics, monocyclic aromatics, phthalate esters, polynuclear aromatics, and pesticide/PCBs.

PCBs are found at 11 of 27 sample locations. PCBs detected include Aroclor-1016, Aroclor-1248, Aroclor-1254, and Aroclor-1060. PCB contamination does not appear to be limited to one area of the site. Though the highest concentrations were detected in samples collected from the central portion of the site (SO-8 and 12), near the former lagoons, PCBs were also detected near the site entrance (SO-5 and 6) and in the northernmost portion of the site, behind General Hose (SO-17 and SD-6).

PAHs were detected at only four surface sample locations, two of which exhibited several PAHs (SO-6 and 12). The PAHs detected in the highest concentrations at these two locations were fluoranthene, pyrene, and chrysene. Notably, the highest number and concentration of PAHs were detected in a sample collected off site, from a soil pile behind the Heisler Machine Company (SO-15). Any sample/site relationship here is not known.

Background locations (SO-20 and SO-23) exhibit no organic HSL contamination. Other offsite surface soil samples (from locations SO-1 through 4) exhibit low levels of xylene and ethylbenzene.

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TABLE 4-3

SUMMARY OF SURFACE SOIL/SEDIMENT CONTAMINATION FOUND IN THIS INVESTIGATION
CALDWELL TRUCKING COMPANY SITE

PP #	CAS #	Contaminant Name	Concentration Range (µg/l)	Number of Occurrences/ Number of Samples*
		Chlorinated Aliphatics		
30V	156-60-5	trans-1,2-dichloroethene	5	1/27
85V	127-18-4	tetrachloroethene	5 - 7,500	4/27
87V	79-01-6	trichloroethene	5 - 5,800	5/27
23V	67-66-3	chloroform	33	1/27
11V	71-55-6	1,1,1-trichloroethane	5 - 1,300	2/27
		Monocyclic Aromatics		
86V	108-88-3	toluene	5 - 560	6/27
38V	100-41-4	ethylbenzene	5 - 4,200	3/27
		total xylenes	5 - 25,000	10/27
		Polynuclear Aromatics		
55B	91-20-3	naphthalene	310	1/27
1B	83-32-9	acenaphthene	330	1/27
80B	86-73-7	fluorene	330	1/27
81B	85-01-8	phenanthrene	330 - 2,600	5/27
78B	120-12-7	anthracene	330	2/27
39B	206-44-0	fluoranthene	330 - 6,100	6/27
89B	129-00-0	pyrene	330 - 3,900	5/27
72B	56-55-3	benzo(a)anthracene	330 - 2,500	4/27
76B	218-01-9	chrysene	410 - 3,800	4/27
74B	205-99-2	benzo(b)fluoranthene	330 - 3,300	4/27
75B	207-06-9	benzo(k)fluoranthene	330 - 2,700	4/27
73B	50-33-8	benzo(a)pyrene	330 - 7,800	4/27
83B	193-39-5	ideno(1,2,3-cd)pyrene	330 - 440	2/27
79B	191-24-2	benzo(g,h,i)perylene	330 - 1,400	3/27
NP	106-47-8	4-chloroaniline	330	1/27

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TABLE 4-3
SUMMARY OF SURFACE SOIL/SEDIMENT CONTAMINATION FOUND IN THIS INVESTIGATION
CALDWELL TRUCKING COMPANY SITE
PAGE TWO

PP #	CAS #	Contaminant Name	Concentration Range (µg/l)	Number of Occurrences/ Number of Samples*
		Phthalate Esters		
70B	84-66-2	diethylphthalate	330	1/27
66B	117-81-7	bis(2-ethylhexyl)phthalate	490	1/27
		Pesticides/PCBs		
94P	74-54-8	4,4'-DDD	17 - 210	2/27
112P	12674-11-2	Aroclor 1016	24,000	1/27
110P	12672-29-6	Aroclor 1248	280 - 76,000	4/27
107P	11097-69-1	Aroclor 1254	210 - 890	5/27
95P	959-98-8	Endosulfan I	8.9	1/27
111P	11096-82-5	Aroclor 1260	140 - 2,100	2/27
92P	50-29-3	4,4'-DDT	95	1/27

Notes:

* *Data includes samples SD101 thru 106, SD110, and LSS002 and 006*

NP = Non-Priority Pollutant

Substantial quantities of volatile contaminants were detected in the surface soil sample collected at lagoon Boring 6 (location SO-18). Chemicals detected here include the following: chloroform (310 µg/kg); 1,1,1-trichloroethane (1,300 µg/kg); trichloroethene (5,800 µg/kg); tetrachloroethene (7,500 µg/kg); toluene (560 µg/kg); ethylbenzene (4,200 µg/kg); and total xylenes (25,000 µg/kg). This sample represents the only detection of substantial volatile contamination in surface soils, though these compounds have been detected at similar levels in other site media.

In comparison to background samples (locations SO-20 and SO-23), some site surface soils exhibit elevated levels of lead and mercury. Generally, the samples which demonstrated lead contamination, also demonstrated mercury contamination. A location on site behind General Hose (SO-17), exhibited the highest levels of lead (8,110 µg/g) and mercury (3.5 µg/g) as compared to 0 to 42 µg Pb/g and 0 µg Hg/g in the background samples. Other locations exhibiting high levels of both metals are SO-6, 7, and 8, and SD-6.

4.5.2.2 Subsurface Soils

Lagoon soil-boring samples are contaminated with high concentrations of a wide variety of organic and inorganic HSL contaminants. The array of chemicals detected include organics from the following classes: chlorinated aliphatics; monocyclic aromatics; polynuclear aromatics; and pesticides/PCBs. Borings 7, 9, 10, 11, 13, 14, and 15 in the lagoon area represent the area of greatest subsurface contamination. Figure 4-17 shows the location of all borings and Figures 4-18 and 4-19 depict the depth-specific total volatile organics contamination in the lagoon borings. The discussion of extent of contamination in the lagoon area proceeds by discussing the contamination in each boring mentioned above. Other borings, exhibiting lesser amounts of contamination, are discussed later. A summary of subsurface soil contamination is shown in Table 4-4.

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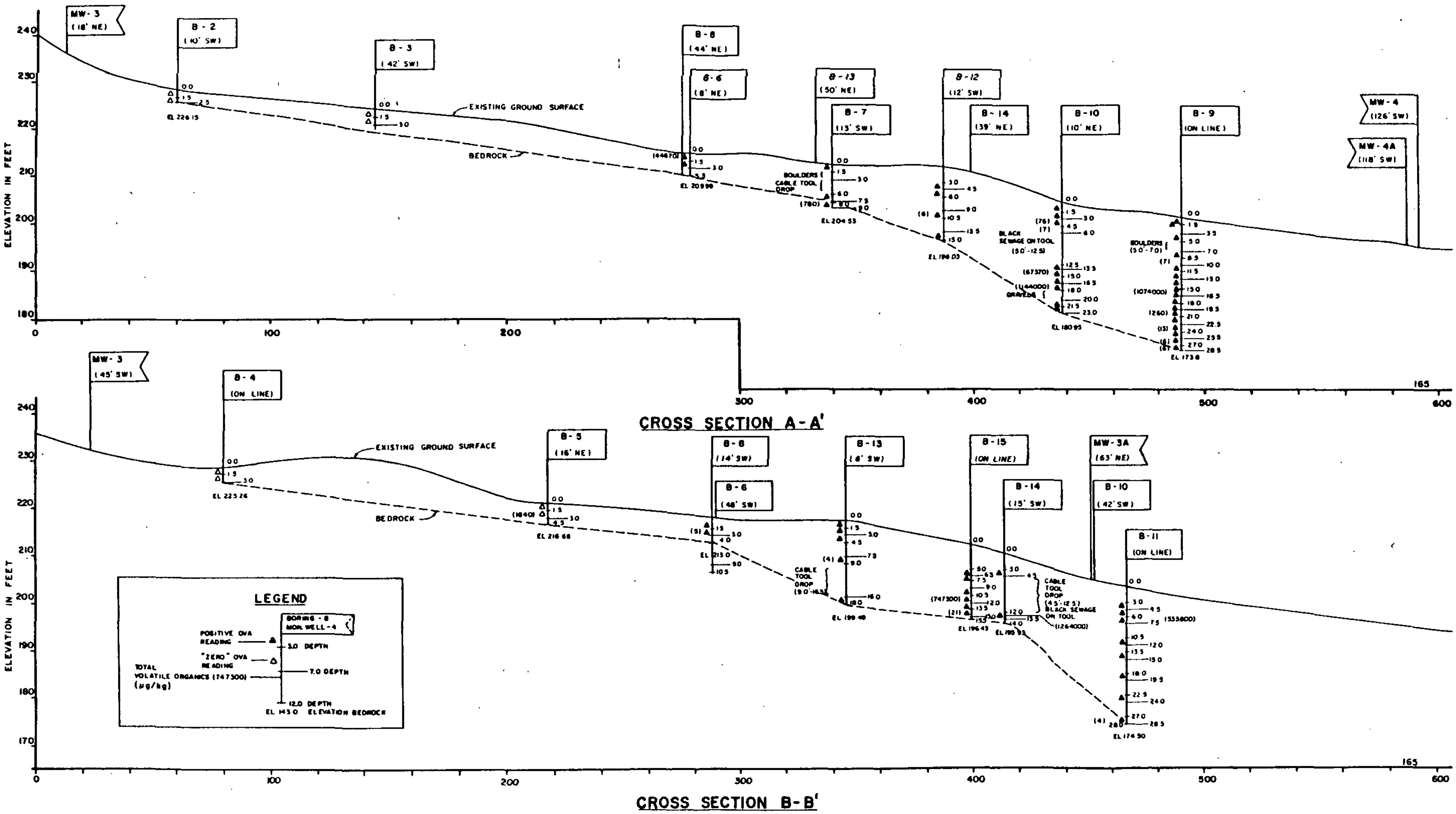

FIGURE 4-18

TOTAL HSL VOLATILE ORGANICS (μg/kg)
CROSS SECTIONS OF LAGOON AREA
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

0 40 80
HORIZONTAL SCALE IN FEET

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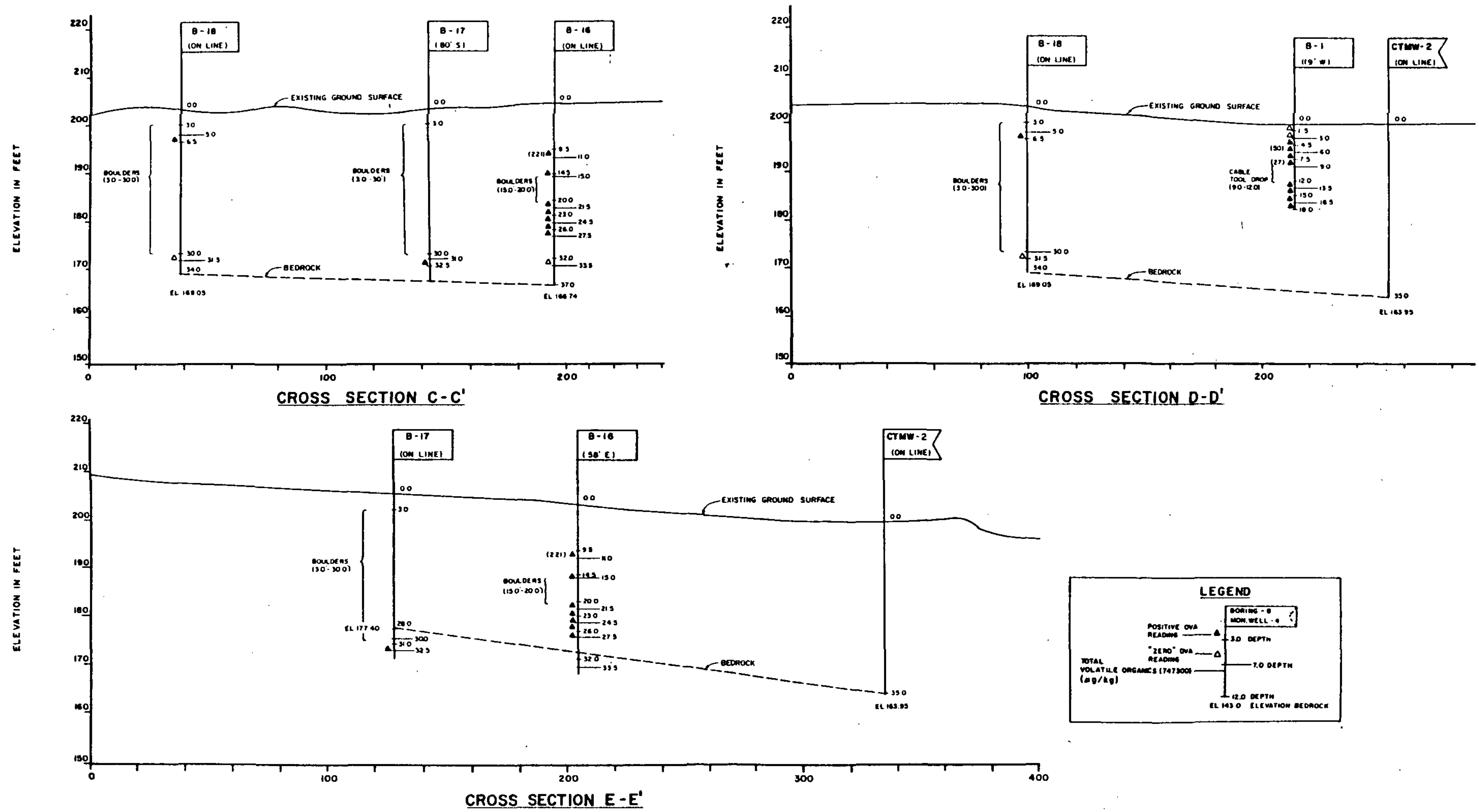

FIGURE 4-19

TOTAL HSL VOLATILE ORGANICS (µg/kg)
CROSS SECTIONS OF SEEPAGE LAGOON AREA
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

0 40 80
HORIZONTAL SCALE IN FEET

NUS CORPORATION
A Halliburton Company

CTC 001 0447

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TABLE 4-4

SUMMARY OF SUBSURFACE SOIL CONTAMINATION FOUND IN THIS INVESTIGATION
CALDWELL TRUCKING COMPANY SITE

PP #	Subsurface Soils CAS #	Contaminant Name	Concentration Range (µg/l)	Number of Occurrences/ Number of Samples*
30V	156-60-5	Trans-1,2-Dichloroethene	3.1 - 21,000	10/58
23V	67-66-3	Chloroform	2.5 - 14,000	4/58
10V	107-06-2	1,1-Dichloroethane	180 - 30,000	3/58
11V	71-55-6	1,1,1-Trichloroethane	4.0 - 240,000	6/58
87V	79-01-6	Trichloroethene	100 - 790,000	9/58
85V	127-18-4	Tetrachloroethene	4.1 - 840,000	17/58
86V	108-88-3	Toluene	1,600 - 94,000	8/58
38V	100-41-4	Ethylbenzene	7.7 - 66,000	4/58
7V	108-90-7	Chlorobenzene	9	1/58
29V	75-35-4	1,1-Dichloroethene	160	1/58
65A	108-95-2	Phenol	280-15,000	4/56
62B	62-75-9	N-Nitrosodiphenylmine	410	1/58
26B	541-73-1	1,3-Dichlorobenzene	240 - 6,800	3/58
27B	106-46-7	1,4-Dichlorobenzene	260 - 16,000	7/58
25B	95-50-1	1,2-Dichlorobenzene	410 - 44,000	6/58
8B	120-82-1	1,2,4-Trichlorobenzene	190 - 3,400	2/58
55B	91-20-3	Napthalene	190 - 3,100	6/58
77B	208-96-8	Acenaphthylene	940	1/58
1B	83-32-9	Acenaphthene	180 - 2,800	4/58
20B	86-73-7	Fluorene	540 - 3,600	3/58
81B	85-01-8	Phenanthrene	350 - 8,900	5/58
68B	84-79-2	Di-n-butylphthalate	280 - 380	2/58
39B	206-44-0	Fluoranthene	240 - 4,800	5/58
84B	129-00-0	Pyrene	230 - 9,000	4/58
67B	85-68-7	Butylbenzylphthalate	220	1/58
66B	117-81-7	Bis(2-ethylhexyl)phthalate	180 - 9,000	16/58

CTC 001 0448

TABLE 4-4
SUMMARY OF SUBSURFACE SOIL CONTAMINATION FOUND IN THIS INVESTIGATION
CALDWELL TRUCKING COMPANY SITE
PAGE TWO

	Subsurface Soils			
PP #	CAS #	Contaminant Name	Concentration Range (μg/l)	Number of Occurrences/ Number of Samples*
93P	72-55-9	4,4'-DDE	620	1/58
94P	74-54-8	4,4'-DDD	8.4 - 4,000	2/58
92P	50-29-3	4,4'-DDT	120 - 28,000	2/58
106P	53469-21-9	Arochlor 1242	930 - 360,000	8/58
110P	12672-29-6	Arochlor 1248	340	1/58
107P	11097-69-1	Arochlor 1254	180 - 3,600	4/58
NP	75-15-0	Carbon disulfide	3.6	1/58
		Total xylenes	3.7 - 280,000	8/58
NP	95-48-7	2-Methylphenol	9,700 - 14,000	2/58
NP	106-44-5	4-Methylphenol	2,400 - 14,000	3/58
NP	65-85-0	Benzoic acid	1,100	1/58
NP	91-59-6	2-Methylnaphthalene	260 - 3,400	5/58
NP	132-64-9	Dibenzofuran	290 - 2,800	4/58

Notes:

* Data includes all LSS samples (except 002 and 006) and SS001, SS004 - 008

NP = Non-Priority Pollutant

Boring 7 exhibits a pocket of contamination at a depth of approximately 8 feet. The only volatile organic detected here was tetrachloroethene at 780 µg/kg. Other organics detected were phenol, 4-methylphenol, and chlorinated benzenes, including 1,2-dichloro-, 1,3-dichloro-, and 1,4-dichlorobenzenes. Also detected was Aroclor-1242 at 28,000 µg/kg. Elevated levels of inorganics, including lead (1,600 µg/g), barium (3,400 µg/g), and mercury (3.5 µg/g) were also present.

The primary contaminants in Boring 9 are volatiles. The most significant concentration of volatiles in Boring 9 were detected at a depth of 14 to 16.5 feet. Volatiles detected here were trichloroethene (210,000 µg/kg), tetrachloroethene (840,000 µg/kg), and toluene (24,000 µg/kg). 4,4'-DDD (8.4 µg/kg) was detected in a sample collected from 8.5 to 10 feet.

Boring 10 samples contained a wide assortment of contaminants. The bulk of the volatile contamination was detected in samples collected from 14 to 18.5 feet. Volatiles detected here include chloroform, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, and toluene. The main slug of volatile contamination found in a sample collected from a depth of 17 to 18.5 feet contained 1,144,000 µg/kg total volatiles. Also detected in this sample was 280,000 µg/kg Aroclor-1242. A similar concentration of Aroclor-1242 (290,000 µg/kg) was detected at 20 to 21.5 feet. Also, pesticides, including 4,4'-DDD (4,000 µg/kg), 4,4'-DDE (620 µg/kg) and 4,4'-DDT (120 µg/kg) were detected at 3 to 4.5 feet.

Boring 11 exhibits contamination very similar to that of Boring 10. Volatile contamination is predominant at 6 to 7.5 feet. Total volatile organics here equal 538,800 µg/kg. Also found at this depth was Aroclor-1254 (1,700 µg/kg) and an elevated lead concentration (11,000 µg/g). Aroclor-1242 (930 µg/kg) was detected in a sample collected at 27 to 28 feet.

Unlike many of the other lagoon borings, Boring 13 exhibits little volatile contamination but does demonstrate a number of other contaminants. Base/neutral extractable contaminants present include chlorinated benzenes, polynuclear aromatics, and phthalate esters. The majority of the contamination was detected

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in a sample collected from a depth of 7.5 to 9 feet. Also detected here were Aroclor-1242 (12,000 µg/kg) and Aroclor-1254 (3,400 µg/kg). High levels of inorganics including barium (12,000 µg/g), copper (440 µg/g), lead (98,000 µg/g), mercury (12 µg/g), manganese (4,600 µg/g), nickel (640 µg/g), and zinc (2,900 µg/g) were also detected.

Boring 14 is highly contaminated with volatiles and several other chemical groups. A sample collected from 12.5 to 14 feet displays a total volatile concentration of 1,264,000 µg/kg. Volatiles detected include 1,1-dichloroethane, trans-1,2-dichloroethene, chloroform, 1,1,1-trichloroethane, trichloroethene, tetrachloroethene, toluene, ethylbenzene, and xylenes. Base/neutral extractable organics detected in this sample totaled 98,100 µg/kg and include chlorinated benzenes, cresols, naphthalene, and bis(2-ethylhexyl)phthalate. Phenol (10,000 µg/kg) was the only acid-extractable detected. Also present were Aroclor-1242 at 360,000 µg/kg, and elevated levels of barium (3,300 µg/g) and lead (31,000 µg/g).

Boring 15 displayed much the same contamination as Boring 14, primarily at a depth of 11 to 12.5 feet. Volatiles totaled 747,300 µg/kg in this sample. In addition to chlorinated benzenes and cresols, this sample also exhibited an assortment of PAHs, including acenaphthene, fluorene, phenanthrene, fluoranthene, and pyrene. Phenol (15,000 µg/kg) was also detected in this sample, as were Aroclor-1242 (14,000 µg/kg) and Aroclor-1254 (3,600 µg/kg). Inorganics detected at elevated levels again were barium and lead. Aroclor 1242 (4,600 µg/kg) was also detected in a sample collected from 14 to 15.5 feet in this boring.

Borings 1 and 16, located behind General Hose in the seepage lagoon area exhibit much lower levels of contamination, though volatiles, Aroclors (PCBs), polynuclear aromatics, and elevated metal levels were detected.

Contamination in Boring 1 was limited to two samples collected at 4.5 to 6 feet (CT-LSS-001A) and at 7.5 to 9 feet (CT-LSS-001B). Comparatively, volatile contamination was low (TVO_S = 49.7 and 27.1 µg/kg, respectively). Sample

CT-LSS-001A contained several PAHs, including naphthalene, 2-methylnaphthalene, acenaphthylene, fluorene, phenanthrene, fluoranthene, and pyrene, totalling 7,660 µg/kg. Sample CT-LSS-001B contained only acenaphthene (180 µg/kg), phenanthrene (350 µg/kg) and fluoranthene (240 µg/kg). Both samples exhibited elevated levels of lead (5,600 µg/g and 6,200 µg/g).

Volatiles, Aroclors, and elevated metal concentrations were detected in Boring 16 at 9.5 to 11 feet. Volatiles detected include 1,1-dichloroethene (86 µg/kg), trichloroethene (100 µg/kg), chlorobenzene (24 µg/kg), and xylenes (11 µg/kg). Both Aroclor-1248 (340 µg/kg) and Aroclor-1254 (180 µg/kg) were detected. Also, as in the settling lagoon area, lead (1,800 µg/g) and mercury (3.8 µg/g) were encountered at elevated levels.

Subsurface soils collected from monitoring well borings during the drilling revealed little contamination with one exception. Soil collected from a depth of 20 to 21.5 feet in monitoring well MW-3A exhibited a total volatile concentration of 7,425 µg/kg, including 5,000 µg/kg of trichloroethene.

Figure 4-20 shows the approximate extent of subsurface soil contamination determined in this study.

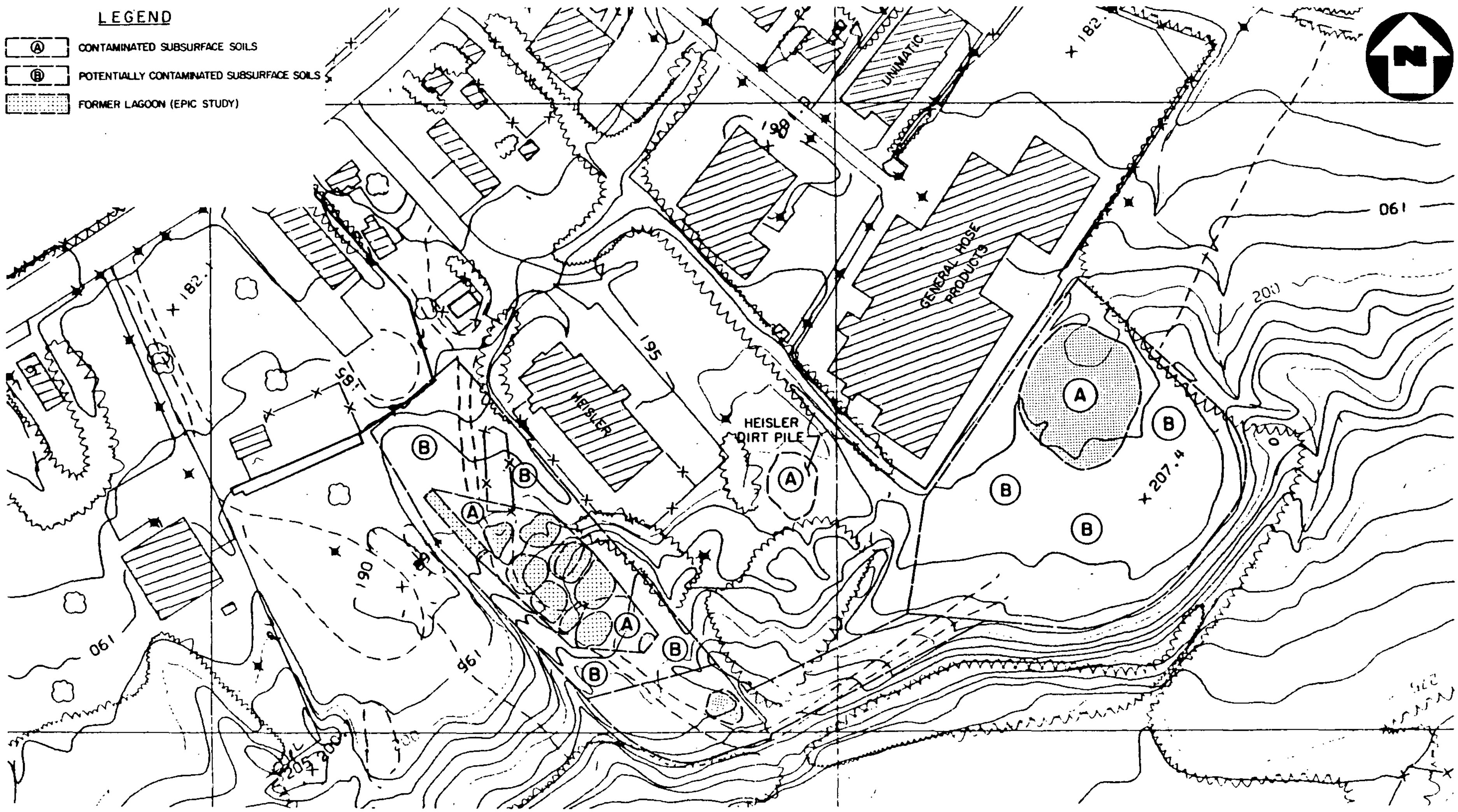

FIGURE 4-20

APPROXIMATE EXTENT OF CONTAMINATED SUBSURFACE SOILS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

0 150 300
SCALE IN FEET

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5.0 SURFACE WATER AND SEDIMENT INVESTIGATION

5.1 Drainage

Surface water drainage in the study area flows ultimately to the Passaic River, approximately 3,000 feet to the northeast of the project site. Unnamed small streams and drainage ditches flow from the higher grounds of the site north to the Deepavaal Brook. In addition, surface drainage from high grounds southeast of the site flows to the lower wetland areas near the airport. These wetland areas are drained by Deepavaal Brook, that flows to the northeast and discharges into the Passaic River.

The area adjacent to Municipal Well No. 7 is drained by Green Brook which flows west into Deepavaal Brook.

5.2 Sampling and Analysis

Surface waters and sediments were sampled in the site area to investigate the impact of runoff from the site. The sampling locations are shown in Figure 5-1. One round of sampling was performed at all locations except SW/SD-7 and 8 where a second round was also collected to confirm first round results. Samples were collected during dry weather conditions. A total of eight surface water and eleven sediment samples were taken. Both water and sediment samples were composited from three locations across Deepavaal Brook at each location. Samples from the tributaries and the Passaic River were grab samples from the first few inches of sediment and from the water surface. All samples were analyzed for HSL organic and inorganic compounds while the water samples were also analyzed for a broad range of water quality and contamination indicator parameters (same as groundwater analyses). The results are included in Appendix C.

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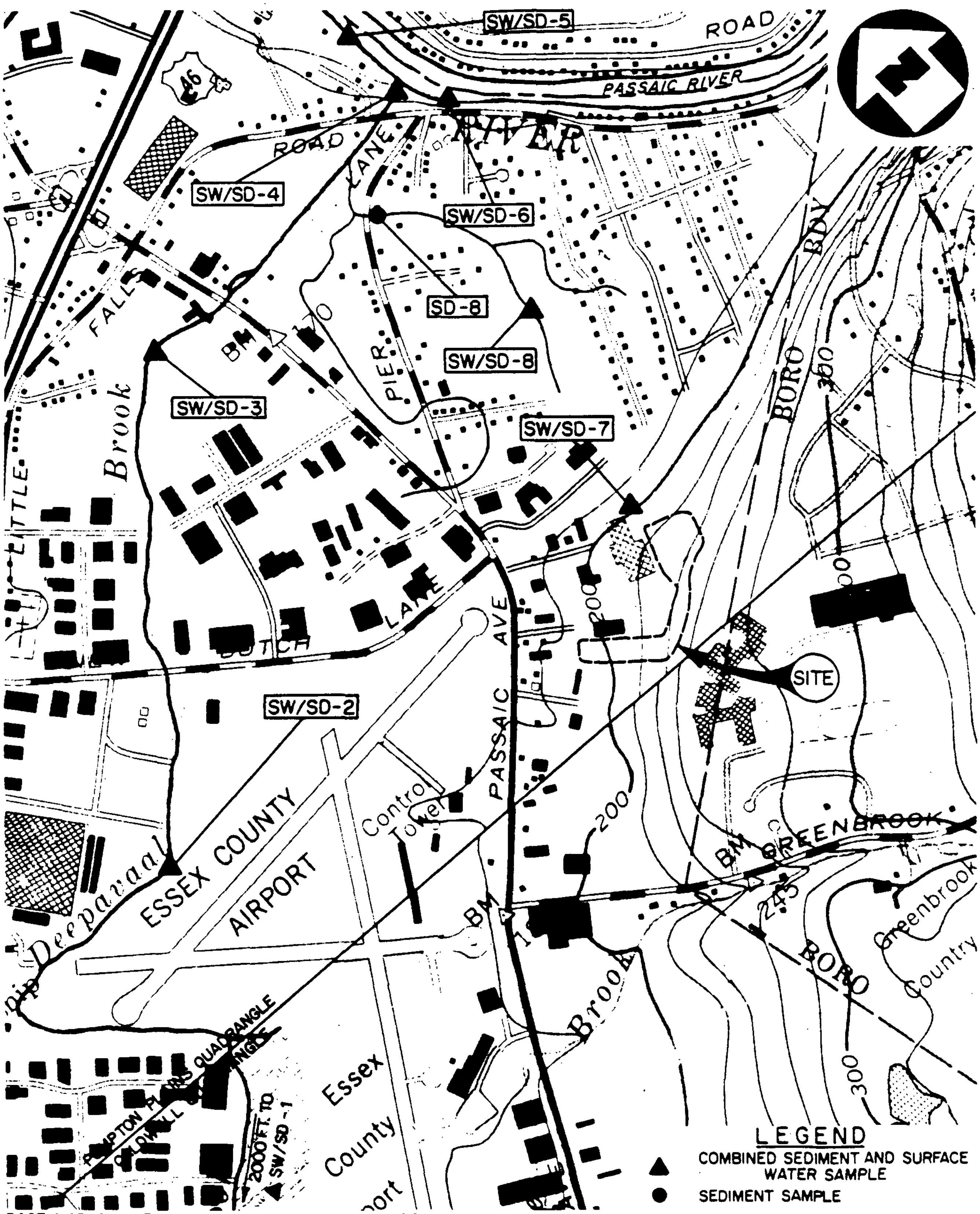

BASE MAP IS AN ENLARGEMENT OF A PORTION OF FIGURE 2-1.

FIGURE 5-1

SURFACE WATER & SEDIMENT SAMPLING LOCATIONS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

SCALE: 1"=1000'

NUS CORPORATION
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CTC 001 0455

5.3 Extent of Contamination

Surface Water

Table 5-1 summarizes the surface water contamination detected in the vicinity of the Caldwell Trucking Company Site. Volatile organics, primarily chlorinated aliphatics are the major contaminants in the surface waters. Methylene chloride was detected in seven of eight samples (maximum 854 µg/L), including background locations SW/SD-1 and SW/SD-2 where 44 µg/L and 160 µg/L methylene chloride, respectively, were detected. Other chlorinated aliphatics detected include trans-1,2-dichloroethene, chloroform, trichloroethene, tetrachloroethene, 1,1-dichloroethene, and 1,1,1-trichloroethane.

A surface water sample taken at location SW/SD-7 was the most contaminated, with a total volatile concentration of 2,043 µg/L. Benzo(a)pyrene was also detected in this sample at 11µg/L. Other compounds detected in surface waters were benzene (two detections at 4 and 36 µg/L) and acetone (three detections; 4.6, 5, and 11 µg/l).

Organic contaminants detected at background location SW/SD-2, in addition to methylene chloride, include trans-1,2-dichloroethene, tetrachloroethene, and acetone.

Surface water sample CT-SW-007 (taken at SW/SD-7), exhibiting the highest number and concentrations of contaminants, was collected adjacent to the site in the intermittent stream which drains a portion of the site behind General Hose. This stream empties into Deepavaal Brook, just upstream of where Deepavaal enters the Passaic. Sample CT-SW-006 (location SW/SD-4) was collected in this stretch of Deepavaal Brook and represents the second most contaminated sample (TVO - 898 µg/l).

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TABLE 5-1

SUMMARY OF ORGANIC SURFACE WATER CONTAMINATION FOUND IN THIS INVESTIGATION CALDWELL TRUCKING COMPANY SITE

PP #	CAS #	Contaminant Name	Concentration Range (μg/l)	Number of Occurrences/ Number of Samples
44V	75-09-2	Methylene chloride	44 - 854	7/8
29V	75-35-4	1,1-Dichloroethene	2.6	1/8
30V	156-60-5	Trans-1,2-Dichloroethene	9 - 420	4/8
23V	67-66-3	Chloroform	12	1/8
11V	71-55-6	1,1,1-Trichloroethane	520	1/8
87V	79-01-6	Trichloroethene	340	1/8
85V	127-18-4	Tetrachloroethene	4 - 8	4/8
NP*	67-64-1	Acetone	4.6 - 11	3/8
4V	71-43-2	Benzene	4 - 36	2/8
73B	50-32-8	Benzo(a)pyrene	11	1/8

* NP = Non-priority pollutant

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Inorganic analyses, in relation to background samples collected at locations SW/SD-1 and SW/SD-2 and in relation to relevant water quality parameters, such as the Ambient Water Quality Criteria, revealed elevated levels of arsenic, lead, and nickel at locations SW/SD-7 and 8. The background samples exhibited nickel at 22 to 39 mg/L, lead at 14 to 26 mg/L, and did not exhibit arsenic above the detection limit. On the other hand, SW/SD-8 contained 634 mg/L lead, 63 mg/L nickel, and 16 mg/L arsenic.

Sediment

Table 5-2 summarizes the extent of contamination detected in sediment samples collected from surface waters in the vicinity of the Caldwell Trucking Company Site. HSL organic contamination detected in sediment samples include chemicals from the following classes: chlorinated aliphatics, monocyclic aromatics, polynuclear aromatics, and PCBs.

Chlorinated aliphatics were detected at locations SW/SD-3, SD-8, SW/SD-7, and SD-110. The greatest number of chlorinated aliphatics were detected at SW/SD-7 and SD-8, which were collected from the intermittent stream running from behind General Hose Products to Deepavaal Brook (see Figure 5-1).

Several polynuclear aromatics (PAHs) were detected at location SD-8, which is adjacent to Pier Lane. PAHs are common roadway-runoff contaminants.

Two rounds of sampling at location SW/SD-8 verified the existence of Aroclors at this location. The first round of sampling revealed Aroclor-1254, and the second round revealed both Aroclor-1254 and 1248.

Miscellaneous compounds detected include bis(2-ethylhexyl)phthalate at SW/SD-1 (background sample, upstream of site in Deepavaal Brook), and benzoic acid at SD-8. Bis(2-ethylhexyl)phthalate was the only organic compound detected in sediments at the background location.

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TABLE 5-2

SUMMARY OF SEDIMENT CONTAMINATION FOUND IN THIS INVESTIGATION*
CALDWELL TRUCKING COMPANY SITE

PP #	CAS #	Contaminant Name	Concentration Range (µg/l)	Number of Occurrences/ Number of Samples*
10V	75-34-3	1,1-Dichloroethane	9	1/11
23V	67-66-3	Chloroform	2	1/11
11V	71-55-6	1,1,1-Trichloroethane	2 - 5	2/11
30V	156-60-5	Trans-1,2-Dichloroethene	4 - 11	2/11
87V	79-01-6	Trichloroethene	2 - 39	3/11
85V	127-18-4	Tetrachloroethene	11	1/11
86V	108-88-3	Toluene	12	1/11
81B	85-01-8	Phenanthrene	430 - 500	2/11
78B	120-12-7	Anthracene	430	1/11
39B	206-44-0	Fluoranthene	500 - 830	2/11
84B	129-00-0	Pyrene	500 - 930	2/11
72B	56-55-3	Benzo(a)anthracene	490	1/11
76B	218-01-9	Chrysene	570	1/11
74B	205-99-2	Benzo(b)fluoranthene	430	1/11
75B	207-08-9	Benzo(k)fluoranthene	430	1/11
73B	50-32-8	Benzo(a)pyrene	430	1/11
83B	193-39-5	Ideno(1,2,3-cd)pyrene	430	1/11
79B	191-24-2	Benzo(g,h,i)perylene	430	1/11
93P	72-55-9	4,4'-DDE	5.8 - 230	3/11
94P	74-54-8	4,4'-DDD	11 - 160	3/11
110P	12672-29-6	Aroclor 1248	980	1/11
107P	11097-69-1	Aroclor 1254	4,100 - 12,258	2/11
66B	117-81-7	Bis(2-ethylhexyl)phthalate	1,700	1/11
NP	75-15-0	Carbon disulfide	2	1/11

Notes:

* Does not include samples SD101 thru 106 and SD110
NP = Non-priority pollutant

In comparison to the background location (SW/SD-1) (110 mg Pb/kg), samples collected at SW/SD-5 and 8 exhibited elevated levels of lead: 3,960 mg/kg and 569 mg/kg, respectively.

5.4 Flood Potential

The Caldwell Trucking Company Site is located on a hillside adjacent to a broad floodplain area of the Passaic River. Ground elevation ranges on the site from approximately 185 feet to 210 feet mean sea level. The 100-year floodplain elevation of the Passaic River is 171.5 feet mean sea level.

6.0 AIR INVESTIGATION

The objective of the air sampling program was to assess the potential for air emissions of volatile organics under current conditions at the site and to provide data for estimating the potential for air emissions during remedial actions involving ground disturbances. To accomplish this, air sampling was conducted during completion of onsite soil boring B-1. This boring was selected because, during the early stages of drilling, air monitoring with an organic vapor meter indicated a significant release (>1,000 ppm) of volatile organic compounds in the immediate vicinity of the borehole. However, by the time drilling was resumed and air sampling began, the emissions had subsided to the non-detectable level. While the analytical results show the presence of low levels of volatile organic compounds in the immediate vicinity of the borehole, additional organic meter and colorimetric detector tube testing prior to air sampling episode indicated that methane may have been the major contributor to the very high readings detected during the initial stages of drilling B-1.

6.1 Sampling and Analysis

Six air samples were collected at the five locations shown on Figure 6-1. The additional sample was taken as a duplicate at location AS-2. The samples were analyzed for HSL volatile organics. The results are shown in Table 6-1.

6.2 Extent of Contamination

As can be seen in Table 6-1, location AS-2, nearest the borehole, had the highest concentration of volatile organics at 114.2 ppb. At location AS-3, approximately 150 feet downwind of AS-2, the level had decreased significantly to 15.4 ppb (a factor of 7.6); and at AS-4 and AS-5, 240 and 350 feet downwind of AS-2, the levels had decreased to the upwind level of between 5 and 7 ppb. Therefore, it is apparent from the information that very low levels (approximately 100 ppb) of

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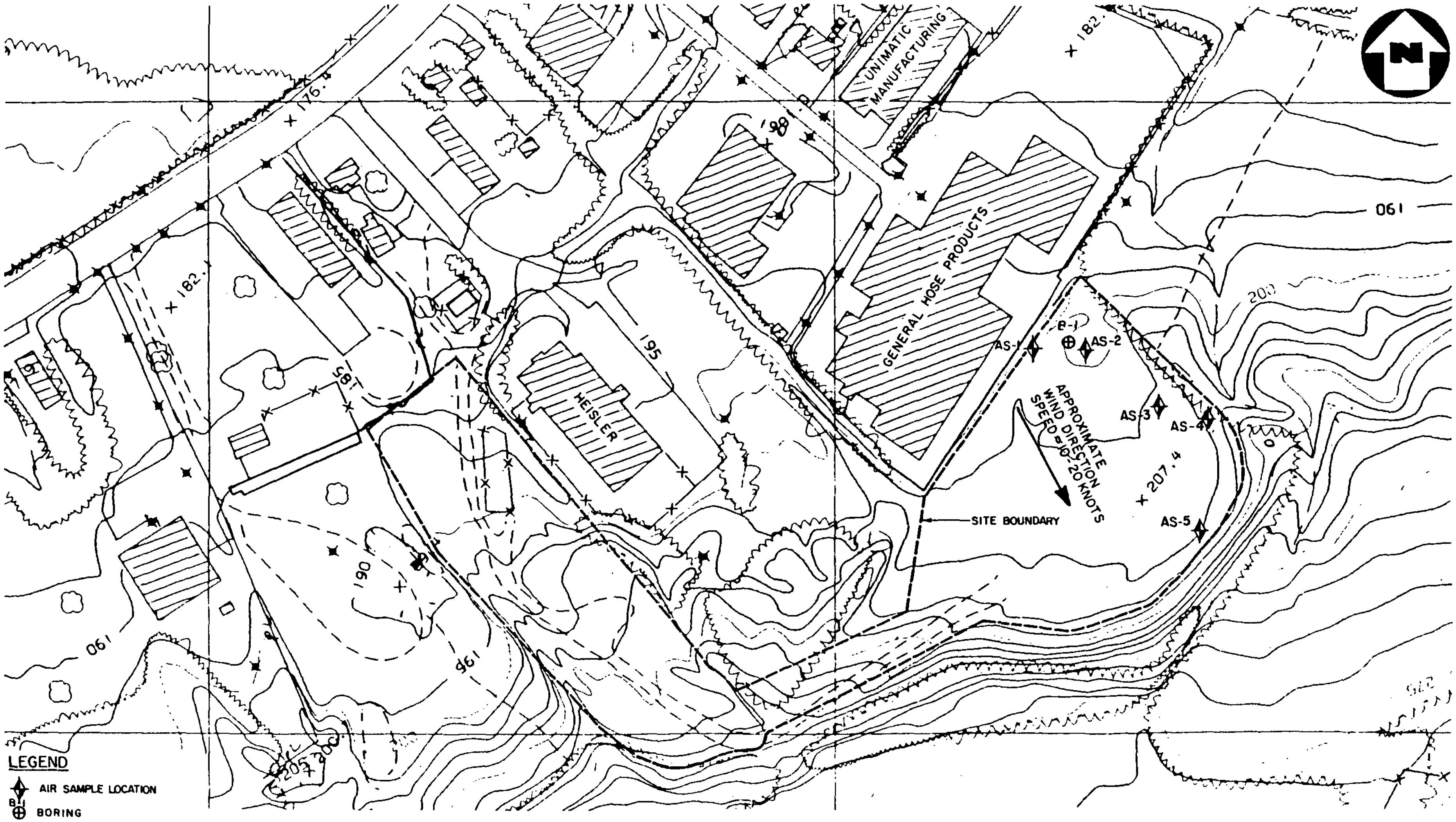

FIGURE 6-1

AIR SAMPLING LOCATIONS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

0 150 300
SCALE IN FEET

6-2

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CTC 001 0462

TABLE 6-1

VOLATILE ORGANIC COMPOUNDS DETECTED IN AIR SAMPLES TAKEN IN THIS INVESTIGATION CALDWELL TRUCKING COMPANY SITE

Compound	Concentration (ppb)				
	AS-1	AS-2[1]	AS-3	AS-4	AS-5
Trans-1,2-Dichloroethene	ND	0.21 / 0.15	ND	ND	ND
1,1,1-Trichloroethane	0.24	0.14 / ND	ND	ND	ND
Trichloroethene	1.52	9.76 / 6.85	0.18	ND	0.11
Benzene[2]	0.13	7.68 / 5.76	1.05	0.34	0.34
Tetrachloroethene	ND	1.25 / 1.48	ND	ND	ND
Toluene[3]	2.16	40.4 /46.6	7.15	2.47	2.63
Ethylbenzene	0.56	9.94 / 9.06	1.49	0.41	0.42
Total Xylenes	1.61	44.8 /38.5	5.27	1.64	1.82
Methyl Ethyl Ketone[4]	0.20	ND / ND	0.22	0.34	ND
Total Volatile Organics	**6.42**	**114.2 /108.4**	**15.4**	**5.20**	**5.32**

Notes:

ND = Not Detected

1: Duplicate samples were taken at this location.
2: Benzene was also detected in reagent blank.
3: Toluene was also detected in the reagent, batch, and field blanks.
4: Methyl ethyl ketone was detected in batch and field blanks in higher concentrations than in the samples.

volatile organics dispersed rapidly during this sampling, with distance from the source, and reached background levels between 150 and 240 feet downwind of the borehole.

These data support the observation that the site, under current conditions, is not likely to be a source of volatile organic compounds in air. However, the data do indicate a potential for release of volatile organics during ground disturbances. Considering the levels of volatiles detected in the subsurface soils (Section 4.0) and the limited disturbance created during soil boring, it may be possible for significant releases of volatile organic compounds to the air to occur during excavation of the highly contaminated areas. The expected magnitude of the releases is impossible to predict using the air quality data generated in this study. However, the data can be used, with some assumptions, to generate a worst case scenario which can be used to predict a maximum expected release. This will be necessary in evaluating the public health and environmental impacts of the remedial alternatives involving significant ground disturbances in the highly contaminated areas. Therefore, it will be addressed in detail as part of the Feasibility Study.

7.0 ENVIRONMENTAL TRANSPORT AND MIGRATION OF CONTAMINANTS

7.1 Environmental Mobility of Chemicals

7.1.1 Organic Mobility

Various chemical and physical parameters affect the mobility of organic chemicals in the environment. These parameters include vapor pressure, water solubility, octanol/water partition coefficient (K_{ow}), soil/sediment adsorption coefficient (K_{oc}), and specific gravity. Table 7-1 presents numerical values for these parameters and for the mobility index for the HSL organic chemicals detected at the Caldwell Trucking Company Site. The mobility index is the logarithmic ratio of three of the preceding parameters: $\log_{10}$ [(water solubility), (vapor pressure), and (soil adsorption coefficient)]. Values presented for K_{ow} and K_{oc} are $\log_{10}$. A brief discussion of the significance of each of these parameters follows.

Vapor Pressure - The vapor pressure of a chemical compound is directly related to the rate at which it volatizes (evaporates or sublimates). Verschueren states that "vapor pressure values provide indications of the tendency of pure substances to vaporize in an unperturbed situation, and thus provide a method for ranking the relative volatilities of chemicals." (Verschueren, 1983).

Water Solubility - The solubility of a chemical is probably the most important factor contributing to groundwater contamination. Lyman states, "Highly soluble chemicals are easily and quickly distributed by the hydrologic cycle. These chemicals tend to have relatively low adsorption coefficients for soils and sediments and relatively low bioconcentration factors in aquatic life." (Lyman, 1982).

Log Octanol/Water Partition Coefficient - This parameter (log K_{ow}) indicates a chemical's tendency to partition between an aqueous and an organic phase and has become increasingly important in environmental fate studies in recent years. The log octanol/water partition coefficient is related to such other parameters as

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TABLE 7-1

MOBILITY PARAMETERS FOR CHEMICALS DETECTED AT THE CALDWELL TRUCKING COMPANY SITE

PP #	CAS #	Chemical	Vapor Pressure mm Hg (@ 20°C)	Water Solubility mg/l (@ 20°C)	Octanol/Water Partition Coefficient	Soil/Sediment Adsorption Coefficient	Specific Gravity (20°C/4°C)	Mobility Index (7)	
		Ketones							
	67-64-1	acetone	270 (@ 30°C) (1)	6 x 10^5 (27)	-0.24 (1)	-0.43/1.25 (2)	0.791 (1)	6.9/6.7	Extremely mobile
	78-93-3	2-butanone	78 (1)	3.5 x 10^5 (1)	0.26 (1)	0.09/1.52 (2)	0.805 (1)	5.9/7.4	Extremely mobile
	591-78-6	2-hexanone	2 (1)	3.5 x 10^4 (1)	1.38 (1)	1.17/2.13 (2)	0.830 (0°C/4°C) (1)	2.7/3.7	Very mobile
	108-10-1	4-methyl-2-pentanone	6 (1)	1.9 x 10^4 (1)	1.09 (6)	1.47/2.29 (2)	0.8017 (1)	2.8/3.5	Very mobile
		Chlorinated Aliphatics							
(11V)	71-55-6	1,1,1-trichloroethane	100 (1)	4,400 (1)	2.17 (6)	1.75 (8)	1.339 (1)	4.0	Very mobile
(10V)	107-06-2	1,2-dichloroethane	61 (1)	8,700 (1)	1.48 (6)	1.52 (8)	1.260 (1)	4.2	Very mobile
(13V)	75-34-3	1,1-dichloroethane	180 (1)	5,500 (1)	1.79 (6)	1.63 (8)	1.174 (1)	4.4	Very mobile
(16V)	75-00-3	chloroethane	1,000 (1)	5,740 (1)	1.54 (1)	1.52 (8)	0.92 (0°C/4°C) (1)	5.2	Extremely mobile
(23V)	67-66-3	chloroform	160 (1)	8,000 (1)	1.97 (1)	1.50 (8)	1.480 (1)	4.5	Very mobile
(85V)	127-18-4	tetrachloroethene	14 (1)	150 (@ 25°C) (1)	2.88 (1)	2.6 (8)	1.626 (1)	0.75	Very mobile
(87V)	79-01-6	trichloroethene	60 (1)	1,100 (@ 25°C) (1)	2.29 (6)	2.00 (8)	1.46 (1)	2.7	Very mobile
(30V)	156-60-5	1,2-dichloroethene (26)	200 (@ 14°C) (1)	600 (1)	1.48 (6)	2.17 (8)	1.260 (1)	2.9	Very mobile
(29V)	75-35-4	1,1-dichloroethene	500 (1)	400 (1)	1.48 (6)	2.26 (8)	1.218 (1)	3.0	Very mobile
(88V)	75-01-4	vinyl chloride	2,660 (@ 25°C) (1)	1,100 (@ 25°C) (1)	0.60 (6)	1.91 (8)	0.9121 (1)	4.6	Very mobile
(44V)	75-09-2	methylene chloride	350 (1)	20,000 (1)	1.25 (6)	1.28 (8)	1.327 (7)	5.6	Extremely mobile
(6V)	56-23-5	carbon tetrachloride	90 (1)	800 (1)	2.64 (1)	2.21 (8)	1.59	2.6	Very mobile
		Monocyclic Aromatics							
(4V)	71-43-2	benzene	76 (1)	1,780 (1)	2.13 (1)	1.92 (3)	0.879 (1)	3.2	Very mobile
(38V)	100-41-4	ethylbenzene	7 (1)	152 (1)	3.15 (1)	2.93 (4)	0.867 (1)	0.10	Very mobile
		total xylenes (9)	6 (1)	180 (1)	3.02 (1)	2.84 (4)	0.870 (1)	0.19	Very mobile
(86V)	108-88-3	toluene	22 (1)	515 (1)	2.69 (1)	2.84 (4)	0.867 (1)	1.5	Very mobile
(7V)	108-90-7	chlorobenzene	8.8 (1)	500 (1)	2.84 (1)	2.84 (4)	1.1066 (1)	1.8	Very mobile
(25B)	95-50-1	1,2-dichlorobenzene	1 (1)	100 (1)	3.38 (1)	3.13 (4)	1.305 (1)	-1.1	Slightly mobile
(26B)	541-73-1	1,3-dichlorobenzene	2.3 (6)	80 (@ 22°C) (1)	3.38 (1)	3.17 (4)	1.288 (1)	-0.97	Slightly mobile
(65A)	108-95-2	phenol	0.2 (1)	82,000 (@ 15°C) (1)	1.46 (1)	0.94/2.17 (10)	1.070 (1)	2.94/3.27	Very mobile
	106-44-5	4-methylphenol	0.04 (1)	24,000 (@ 40°C) (1)	1.99 (1)	2.43 (10)	1.035 (1)	0.55	Very mobile
	95-48-7	2-methylphenol	0.24 (@ 25°C) (1)	31,000 (@ 40°C) (1)	NA	NA	1.041 (1)	NC	Assumed very mobile
(27B)	106-46-7	1,4-dichlorobenzene	0.6 (1)	40 (@22°C) (1)	3.38 (1)	3.22 (4)	1.458 (1)	-1.8	Slightly mobile
(8B)	120-82-1	1,2,4-trichlorobenzene	0.42 (@ 25°C) (6)	30 (@ 25°C) (6)	4.26 (6)	3.84 (4)	NA	-2.7	Slightly mobile

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TABLE 7-1
MOBILITY PARAMETERS FOR CHEMICALS DETECTED AT THE CALDWELL TRUCKING COMPANY SITE
PAGE TWO

PP #	CAS #	Chemical	Vapor Pressure mm Hg (@ 20°C)	Water Solubility mg/l (@ 20°C)	Octanol/Water Partition Coefficient	Soil/Sediment Adsorption Coefficient	Specific Gravity (20°C/4°C)	Mobility Index (7)	
		Phthalate Esters							
(66B)	117-81-7	bis(2-ethylhexyl) phthalate	2.7 x 10^{-7} (6)	1.3 (6)	8.73 (6)	3.87/5.13 (10)	0.99 (1) (20°C/20°C)	-13	Immobile
(68B)	84-74-2	di-n-butyl phthalate	0.1 (6)	13 (@ 25°C) (6)	5.2 (6)	3.02/4.21 (10)	1.0465 (1)	-4.1/-2.9	Slightly mobile
(70B)	84-66-2	diethyl phthalate	0.05 (@ 70°C) (6)	210 (1)	3.22 (6)	2.01/3.12 (10)	1.12 (1) (25°C/25°C)	-1.5/-0.36	Slightly mobile
(67B)	85-68-7	butyl benzyl phthalate	8.6 x 10^{-6} (1)	2.9 (1)	4.78 (1)	3.30/3.97 (10)	1.1 (1) (25°C/25°C)	-8.6/-7.9	Immobile
(69B)	117-84-0	di-n-octyl phthalate	1.2 (@ 200°C) (1)	0.285 (1) (24°C)	9.2 (6)	3.30/8.30 (10)	0.99 (1) (20°C/20°C)	-6.8/-3.8	Slightly mobile
		Polynuclear Aromatics							
(55B)	91-20-3	naphthalene	1 (@ 53°C) (1)	30 (1)	3.37 (1)	1.72/3.16 (4)	1.15 (1)	-1.7/-0.24	Slightly mobile
	91-57-3	2-methylnaphthalene	1 (@ 53°C) (11)	25-28 (@25°C) (12)	4.26 (15)	2.2/3.92 (4)	0.994 (1)	-2.4/-0.77	Slightly mobile
(1B)	83-32-9	acenaphthene	10^{-3}-10^{-2} (6)	3.42 (@ 25°C) (6)	4.33 (6)	4.22 (4)	0.899 (1)	-6.7	Immobile
(39B)	206-44-0	fluoranthene	10^{-6}-10^{-4} (6)	0.265 (@ 25°C) (1)	5.33 (6)	4.84 (4)	NA	-9.4	Immobile
(84B)	129-00-0	pyrene	6.85 x 10^{-7} (6)	0.14 (@ 25°C) (6)	5.32 (6)	4.81 (4)	NA	-11.9	Immobile
(73B)	50-32-8	benzo(a)pyrene	5 x 10^{-9} (6)	0.0038 (@ 25°C) (6)	6.04 (6)	5.72 (4)	NA	-16.4	Immobile
(75B)	207-08-9	benzo(k)fluoranthene	9.59 x 10^{-11} (6)	0.0016 (@ 25°C) (16)	6.84 (6)	6.22 (4)	NA	-19	Immobile
(79B)	191-24-2	benzo(g,h,i)perylene	10^{-10} (6)	0.00026 (@ 25°C) (1)	7.23 (6)	6.64 (4)	NA	-20	Immobile
(80B)	86-73-7	fluorene	10^{-3}-10^{-2} (6)	1.9 (@ 25°C) (1)	4.18 (6)	3.87 (4)	NA	-6.7	Immobile
(81B)	85-01-8	phenanthrene	6.8 x 10^{-4} (6)	0.816 (@ 21°C) (6)	4.46 (1)	4.36 (4)	1.025 (1)	-7.5	Immobile
(83B)	193-39-5	indeno(1,2,3-cd) pyrene	10^{-10} (6)	0.0034 (@ 25°C) (6)	6.3 (17)	5.87 (4)	NA	-10	Immobile
(77B)	208-96-8	Acenaphthylene	10^{-3}-10^{-2}	3.42 (6)	4.33 (6)	4.61 (4)	NA	-8.8	Immobile
(74B)	205-99-2	Benzo(b)fluoranthene	10^{-11}-10^{-6} (6)	0.009 (16)	6.57 (6)	6.26 (9)	NA	-14	Immobile

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TABLE 7-1
MOBILITY PARAMETERS FOR CHEMICALS DETECTED AT THE CALDWELL TRUCKING COMPANY SITE
PAGE THREE

PP #	CAS #	Chemical	Vapor Pressure mm Hg (@ 20°C)	Water Solubility mg/l (@ 20°C)	Octanol/Water Partition Coefficient	Soil/Sediment Adsorption Coefficient	Specific Gravity (20°C/4°C)	Mobility Index (7)	
		Pesticides/PCBs and Related Compounds							
		isophorone	0.38 (1)	12,000 (1)	1.7 (6)	1.65 (24)	0.92 (1)	1.8	Very mobile
(103P)	319-85-7	BHC (beta)	2.8×10^{-7} (6)	0.70 (6)	3.80 (6)	3.36 (24)	NA	-10	Immobile
(95P)	959-98-8	endosulfan I (alpha)	9×10^{-3} (6)	0.26 (6)	3.55 (6)	3.06 (24)	NA	-6.2	Immobile
(92P)	50-29-3	4,4'-DDT	1.9×10^{-7} (1)	0.0034 (@ 20°C) (1)	6.19 (1)	4.89 (24)	NA	-14	Immobile
(93P)	72-55-9	4,4'-DDE	6.5×10^{-6} (6)	0.040 (1)	4.28 (1)	3.86 (24)	NA	-10	Immobile
(106P)	53469-21-9	PCB 1242	4.06×10^{-4} (6)	0.10 (@ 24°C) (1)	5.58	3.80 (24)	1.35 (6)	-6.4	Immobile
(107P)	11097-69-1	PCB 1254	7.7×10^{-5} (6)	0.024 (6)	6.03 (6)	4.69 (24)	1.50 (6)	-10	Immobile
(111P)	11096-82-5	PCB 1260	4.1×10^{-5} (6)	0.003 (6)	6.11 (6)	4.87 (24)	1.58 (6)	-12	Immobile
(97P)	1031-07-8	endosulfan sulfate	9×10^{-3} (28)	0.117 (6)	3.66 (6)	3.76 (24)	NA	-6.7	Immobile
(94P)	74-54-8	4,4'-DDD	10.2×10^{-7}(@ 30°C)(6)	0.09 (@ 25°C) (6)	5.99 (6)	4.47 (24)	NA	-12	Immobile
(112P)	12674-11-2	PCB-1016	4×10^{-4} (@ 25°C)(6)	0.42 (6)	4.38 (6)	2.70 (24)	1.33 (6)	-8.6	Immobile
(110P)	12672-29-6	PCB-1248	4.94×10^{-4} (@25°C)(6)	0.054 (6)	5.75 (6)	4.65 (24)	1.41 (6)	-12.6	Immobile
		Miscellaneous Compounds							
		carbon disulfide	260 (1)	2,300 (@ 22°C) (1)	1.84 (1)	2.88 (24)	1.263 (1)	3.7	Very mobile
		benzoic acid	0.05 (6)	2,900 (1)	1.87 (1)	2.87 (24)	1.27 (1)	1.3	Very mobile
		n-nitroso-diphenylamine	NA	1,100 (28)	2.57 (6)	2.70 (24)	NA	NC	

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TABLE 7-1
MOBILITY PARAMETERS FOR CHEMICALS DETECTED AT THE CALDWELL TRUCKING COMPANY SITE
PAGE FOUR

Notes:

1. Verschueren
2. Lyman; Eq 4-10 and 4-8 respectively
3. Lyman; Eq 4-10
4. Lyman; Average value Eq 4-6 and 4-10
5. Lyman; fragment analysis Chapter 1. log Kow_{MIBK} = log $Kow_{MEK} - f_H + 2f_{CH_3} + f_{CB}$
6. Versar
7. Ford
8. Lyman; Eq 4-7
9. Average values for ortho, meta, and para xylene
10. Lyman; Eq 4-5 and 4-8 respectively
11. No data available, assumed similar vapor pressure as naphthalene
12. Value provided for similar CPD-2-methylnaphthalene
13. No data available, assumed similar to aldrin
14. Lyman; fragment analysis Chapter 1. log $Kow_{styrene}$ = log Kow $(C_8H_{10}) - f_{CH_3} + f_H$ (p 1-34)
15. Lyman; fragment analysis Chapter 1. log $Kow_{2\text{-methylnaphthalene}}$ = $\log Kow_{(naphthalene)} + f_{CH_3}$
16. Lyman, Eq 2-20
17. Lyman; Eq 2-10
18. Lyman; Eq 4-8
19. Lyman; fragment analysis, Chapter 1. log $Kow_{endrin\ aldehyde}$ = log Kow_{endrin} $-F_{*} - f_{-O-} + F_B - f_C + f_{(c(o)h)}$
20. Assumed similar to endosulfan
21. Assumed similar to endrin
22. Assumed similar to heptachlor
23. Lyman; Eq 2-3
24. Lyman; Eq 4-5 and 4-8, average value
25. Weast
26. Parameters presented for more toxic trans isomer.
27. Lyman; Eq. 2-6
28. Lyman; Eq. 2-2

NA Not available
NC Not calculated

solubility, soil adsorption potential, and bioconcentration factors. Lyman indicates the "values of K_{OW} can be considered to have some meaning in themselves, since they represent the tendency of the chemical to partition itself between an organic phase (e.g., a fish, a soil) and an aqueous phase. Chemicals with low K_{OW} values (e.g., less than 10) may be considered relatively hydrophylic; they tend to have high water solubilities, small sediment/soil adsorption coefficients, and small bioconcentration factors for aquatic life. Conversely, chemicals with high K_{OW} values (e.g., greater than 10^4) are very hydrophobic." Such compounds may be expected to adsorb relatively highly to organic soils and exhibit bioaccumulation tendencies, as well as low water solubility.

Log Soil/Sediment Adsorption Coefficient - This parameter (log K_{OC}) provides an indication of the relative tendency for chemicals to adsorb to organic sediments or soils and thus presents a measure of the mobility of chemicals in the hydrosphere. This parameter is considered most useful in assessing groundwater mobilization of contaminants and in addressing migration because of soil erosion. Lyman indicates that this "parameter has an important bearing on assessments to the fate and transport of chemicals in soils and sediments. K_{OC} is commonly used in river models, runoff models, and soil/groundwater models where the transport of a specific chemical is being investigated." Chemicals with relatively high soil adsorption coefficients are generally immobile in the hydrosphere; but, this same tendency makes them mobile with respect to surface water convection (erosion of contaminated soil or sediment particles).

Specific Gravity - This parameter indicates whether a chemical sinks or floats in water. The environmental significance of this parameter is a matter of debate. Cline indicates that gravimetric stratification of chemicals in the environment is generally not affected by specific gravity unless they are present at levels approaching their saturation concentration (Cline and Viste, 1983). Mackay, on the other hand, indicates that "it is convenient to consider organic liquids less dense than water as 'floaters,' which spread across the water table, and organic liquids more dense than water as 'sinkers,' which may plummet through sand and gravel to the underlying aquitard, where present" (ES&T, 1985).

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Mobility Index - This parameter, presented by Ford and Gurba, is the logarithmic ratio of three of the preceding parameters: $\log_{10}$ [(water solubility), (vapor pressure), and (soil adsorption coefficient)]. It is most useful for surface water contamination, and has been found to be of some use in assessing groundwater migration potential.

Literature values for the above parameters have been presented when available. In some cases, parameters were calculated using empirical regression equations determined using experimental results for similarly structured compounds. Since the parameters used are only qualitative indicators of relative mobility, quantitative precision is not considered to be extremely important. For quantitative purposes, experimentally determined compound and site-specific values are necessary.

The chemicals presented in Table 7-1 are subdivided into general classes and are listed in order of descending environmental mobility: ketones > chlorinated aliphatics > monocyclic aromatics > phthalate esters > polynuclear aromatics > pesticides/PCBs. The first three of these classes include constituents of the volatile (purgeable) and acid extractable fractions of the organic HSL. The latter three include constituents of the base/neutral extractable and pesticide/PCB fractions. The environmental behavior of the volatile/acid extractable fractions is markedly different from the base/neutral extractable/pesticide/PCB fractions.

Ketones, chlorinated aliphatics, and monocyclic aromatics generally have higher water solubilities and vapor pressures than the phthalate esters, polynuclear aromatics, and pesticides/PCBs. This makes the volatiles and acid extractables more susceptible to hydrogeologic (groundwater) and atmospheric transport. Compounds in these classes volatilize more readily if present in surface soil or surface water. Their relatively high water solubilities make them prone to leaching by infiltrating precipitation and subject to groundwater transport (advection). The base/neutral extractable and pesticide/PCB fractions, on the other hand, are relatively water insoluble and have lower vapor pressures. These characteristics are reflected by their relatively high soil/sediment adsorption

CTC 001 0471

coefficients. These substances are not as susceptible to volatilization or to groundwater transport. They tend to adsorb to surface or subsurface soil. If spills of these substances occur, the primary mechanism by which they may be transported is convection of particulates with surface water runoff.

8.1.2 Inorganic Mobility

The mobility of inorganic constituents depends on several factors, which must be considered. Among these are pH; Eh; soil cation exchange capacity (CEC), which is an expression of the adsorption potential of clays and organic matter in the soils; complexation ability of an analyte to form more water soluble forms, and, conversely, the availability of various anions needed to form insoluble species. A brief discussion of each of these parameters follows:

pH

pH is the measure of the concentration of the hydrogen ion in a solution. It is expressed as the negative logarithm, i.e., $pH = -\log_{10}[H+]$. Generally, inorganic species are more soluble at lower pHs and more insoluble at higher pH. Also, a sharp increase in binding to soil occurs from pH6 and upwards.

Eh

Eh is commonly referred to as the redox potential and is defined as the energy gained (in volts) in the transfer of 1 mole of electrons from a reductant to one mole of protons (H+). Eh in many ways is analogous to pH. It measures the ability of an environment to take up electrons from a reducing agent or to supply electrons to an oxidizing agent, just as the pH of an environment measures its ability to supply protons to a base or to take up protons from an acid (Krauskopf, 1967).

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Cation Exchange Capacity (CEC)

CEC is an expression of the number of cation absorption sites per unit weight of soil . . . defined as the sum total of exchangeable cations absorbed, expressed in milliequivalents per 100 grams of oven-dry soil (Foth, 1978). CEC affects the retention and release of nutrients and salts and the flocculation-dispersion processes of soil colloids. The attraction of a cation to a negatively charged clay particle generally increases with increasing valency of the cation. Thus, monovalent cations are replaced more easily than divalent or trivalent cations. Highly hydrated cations, which tend to be farther from the surface, are also more easily replaced than less hydrated ones (Hillel, 1971). Order of preference of cations in exchange reactions is generally $Al^{3+} > Ca^{2+} > Mg^{2+} > K^{+} > Na^{+} > Li^{+}$.

Complexation

A complex ion, or complex compound, consists of a central metal cation to which several anions and/or molecules (called ligands) are bonded. In general, the most stable complexes are formed by metal ions that have a high positive charge and a small ionic radius. These smaller, highly charged ions form a variety of slightly soluble species. Complexes formed by monovalent cations, such as the alkali metals, are highly soluble. Trivalent species, despite their tendency to form soluble complexes, are prevented from dissolving because they precipitate out as oxides and hydroxides. For those elements that form small, high-valence cations, which react with oxygen to develop metal-oxygen anions, solubility again tends to be enhanced (Garels & Christ, 1965).

Inorganics detected at slightly elevated levels in surface water or groundwater samples at Caldwell (in comparison to relevant environmental criteria as discussed in Section 8.0) include lead, nickel, cadmium, chromium, silver, and arsenic. A general discussion on the mobility of each of these trace elements follows:

- Lead - added to soil, lead has shown little evidence of entering into drainage. It tends to concentrate at the soil surface where it is fixed very strongly by soil (Leeper, 1978). Soluble forms of lead that do reach surface waters are effectively removed via sorption to sediments.

- Cadmium - Cadmium is relatively mobile in the aquatic environment and may be transported in solution as either hydrated cations or as organic or inorganic complexes. In polluted waters, complexation with organic material is most important (Versar, 1979).

- Nickel - Nickel appears to be relatively mobile in the aquatic environment, as sorption and precipitation do not appear to be as effective as with other metals. Most common aqueous ligands form moderately soluble compounds with nickel (Versar, 1979).

- Chromium - Trivalent chromium (Cr III) reacts with aqueous hydroxide ion to form the insoluble chromium hydroxide ($Cr[OH]_3$). Precipitation of $Cr(OH)_3$ is thought to be the dominant fate of chromium in natural waters. The hexavalent form (CrVI) is quite soluble. Sorption processes remove dissolved chromium (Versar, 1979). Eh conditions determine the valence of chromium.

- Silver - Sorption and precipitation processes are effective in reducing the concentration of dissolved silver. Sorption by manganese dioxide and precipitation with halides are dominant controls (Versar, 1979).

- Arsenic - Arsenic is very mobile in the aquatic environment. Its fate is highly dependent on pH and Eh conditions. Adsorption and desorption to sediment play a key role (Versar, 1979).

CTC 001 0474

7.2 Migration of Contaminants

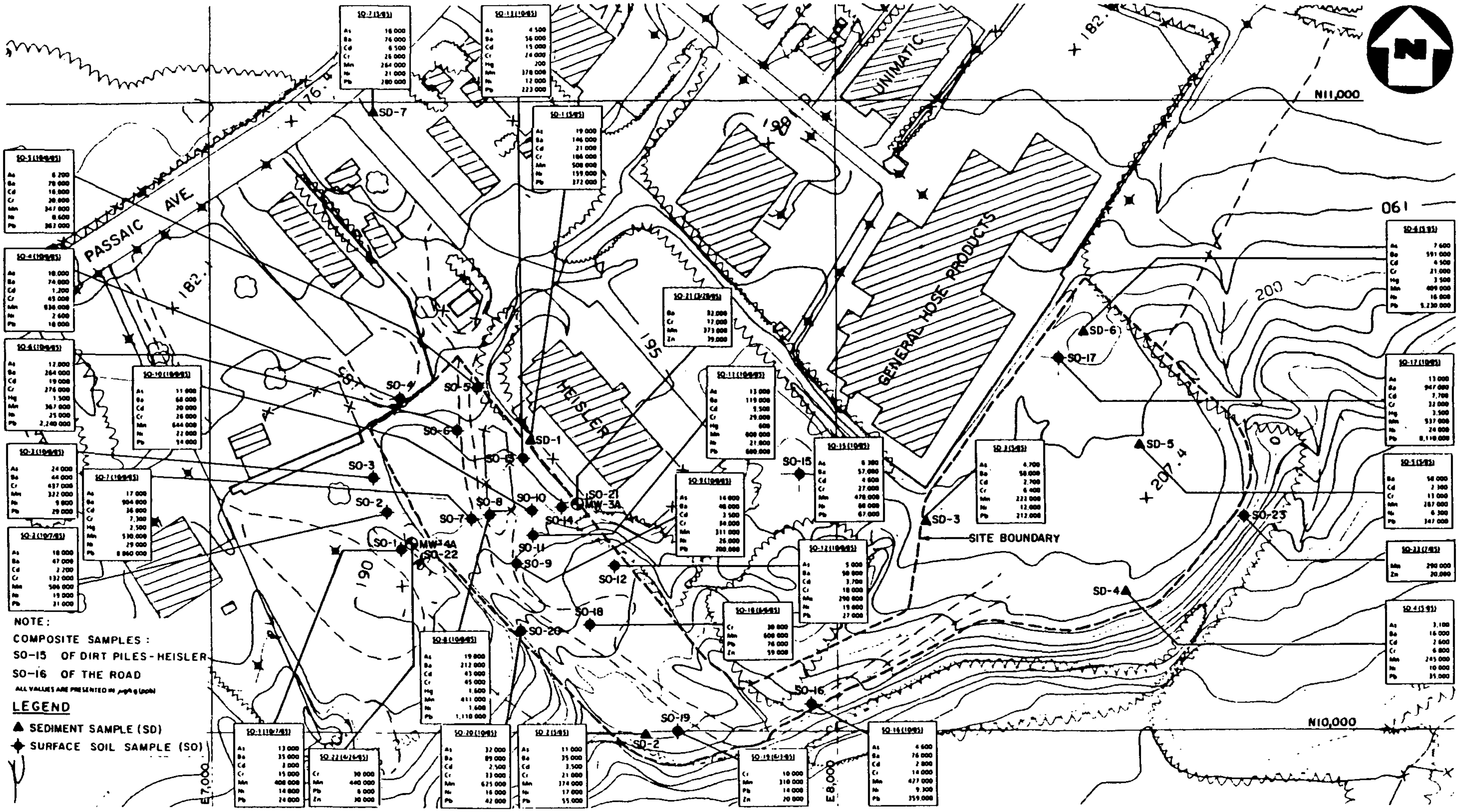
7.2.1 Migration of Soil Contaminants

Site soils, both surface and subsurface, have been contaminated by the waste disposal practices discussed in Section 3.0. The details of site surface soil/sediment contamination and subsurface soil contamination are presented in Section 4.5. Figures 7-1 and 7-2 illustrate the extent of surface soil/sediment contamination by compound.

The extent to which these various soil contaminants migrate from the site is controlled largely by the chemical and physical parameters discussed in Section 7.1. The more water-soluble volatile chemicals either volatilize to the air, solubilize in surface runoff, or leach to the groundwater table. Those volatiles disposed in the subsurface or leached to the subsurface are advected by groundwater away from the site. Volatile contamination of surface soils and site sediments is widespread but very low and may be associated with evapo-transpiration of volatiles from the subsurface. Other compounds, such as PCBs, with higher soil/sediment adsorption coefficients and corresponding lower vapor pressures and water solubilities are more likely to remain bound to site soils and be less mobile. Migration of these compounds is not totally absent, but is predominantly associated with physical movement of soils by surface runoff or wind. The migration of site contaminants to and in surface water and groundwater is detailed in the next two sections.

Speciation controls the mobility of the trace elements. The anion associated with these elements determines the solubility, and thus the mobility. The solubility of an inorganic compound is also dependent on the solution pH and its ionic strength. The solubility increases with the reductions in pH and increase in ionic strength. Modest increases in acidity can markedly increase the solubility and the mobility, while large increases in ionic strength modestly increase the solubility and thus the mobility.

CTC 001 0475



COMPOUND ABBREVIATIONS ARE SHOWN IN FIGURE 7-10.

FIGURE 7-1

INORGANIC CONTAMINATION IN ONSITE SURFACE SOILS AND SEDIMENTS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

150 0 150
SCALE IN FEET

NUS CORPORATION
A Halliburton Company

CTC 001 0476

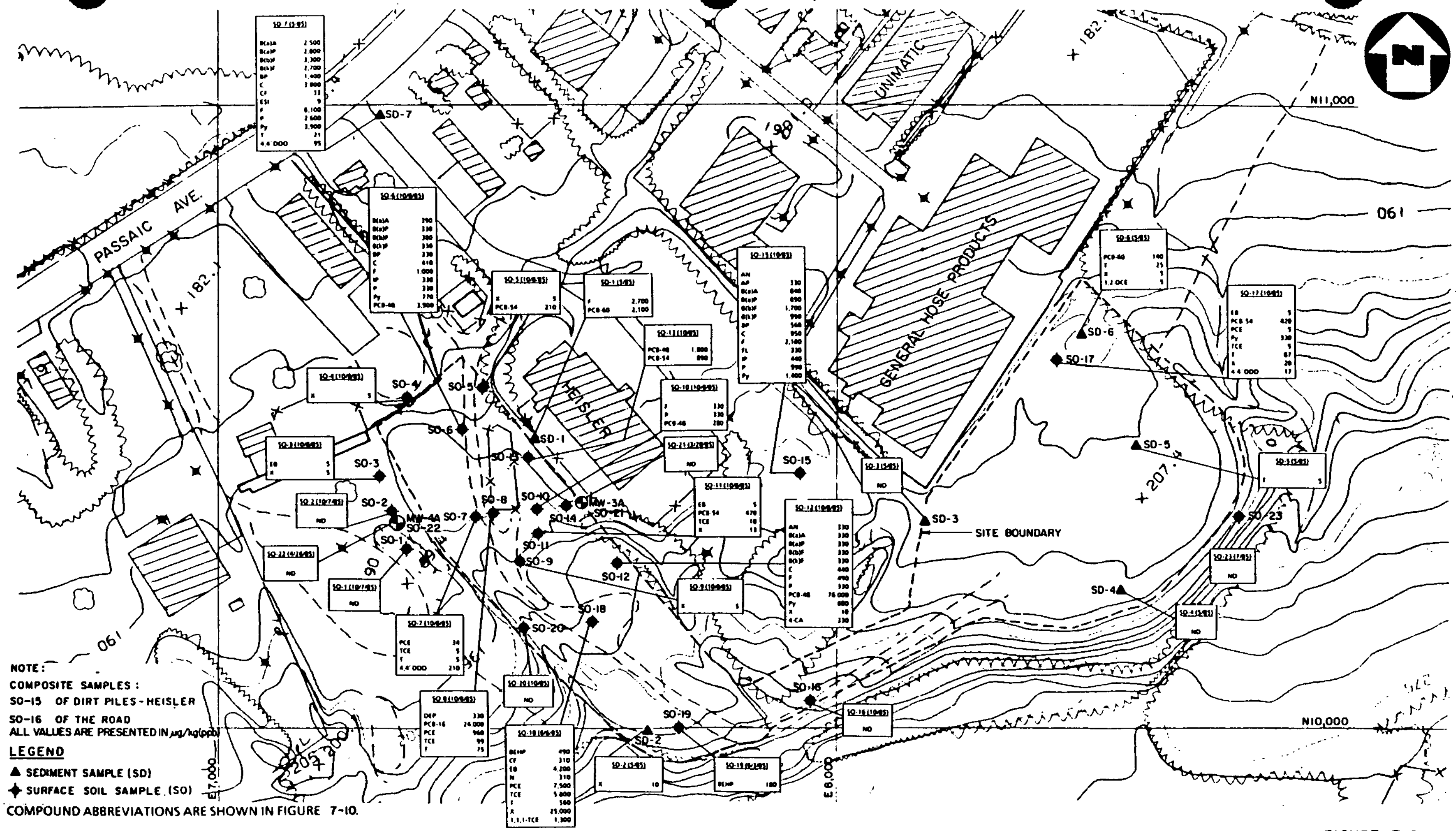


FIGURE 7-2

150 0 150
SCALE IN FEET

ORGANIC CONTAMINATION IN ONSITE SURFACE SOILS AND SEDIMENTS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

NUS CORPORATION
A Halliburton Company

CTC 001 0477

Trace elements also may be transported to surface waters and sediments in undissolved forms while bound to eroding soils.

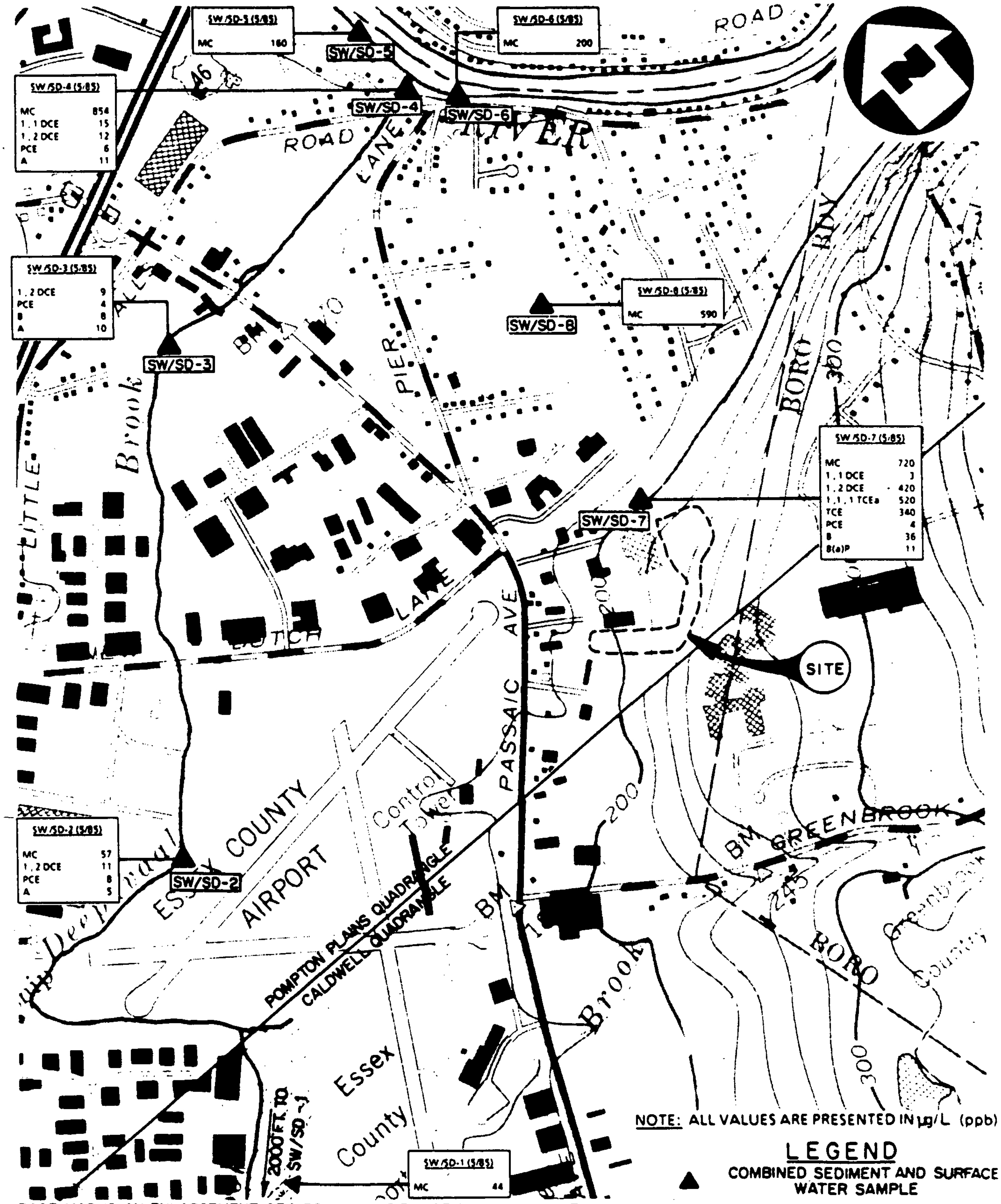
7.2.2 Migration of Surface Water and Sediment Contaminants

Surface water and sediment contamination near the Caldwell Trucking Company Site consists predominantly of volatile organics, though significant concentrations of PCBs and metals also occur. Figures 7-3 through 7-6 illustrate the extent of surface water and sediment contamination in the vicinity of the site. The contaminant distribution in these media suggest that the contamination can be attributed to the site and possibly other areas within the drainage basin.

Contaminants migrating from the site can reach surface waters by two major transport mechanisms: (1) they can be transported as a solute in groundwater that is discharging into surface water; or (2) they can be transported in surface water runoff, either in solution or bound to eroding soil.

Contamination found in the intermittent stream running from behind General Hose Company to Deepavaal Brook is likely to be a product of surface water runoff and groundwater discharge. This stream drains the seepage lagoon area of the site and the seepage pit area of the General Hose parking lot. Volatile contamination of site surface soil is limited and thus suggests that the volatiles in this stream (locations SW/SD 7 and 8, and SD 8) may be attributed to surface runoff from the General Hose Company parking area, where tanks containing several of these volatiles have been reported to be leaking, as well as groundwater discharge from the General Hose seepage pit and Caldwell Trucking Company seepage lagoon areas.

Unlike the volatiles, which are predominantly transported in solution, the PCBs (Arochlor-1254 and 1248) detected in the stream sediments (at SW/SD 8) are likely to have migrated while bound to eroding site soils and settled out here. The detection of these Arochlors in several site surface soil samples, as well as subsurface soil samples, suggests that these compounds may be common surface



BASE MAP IS AN ENLARGEMENT OF A PORTION OF FIGURE 2-1. SEE FIGURE 7-10 FOR COMPOUND ABBREVIATIONS.

FIGURE 7-3

ORGANIC CONTAMINANT CONCENTRATIONS IN SURFACE WATER

CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

SCALE: 1" = 1000'

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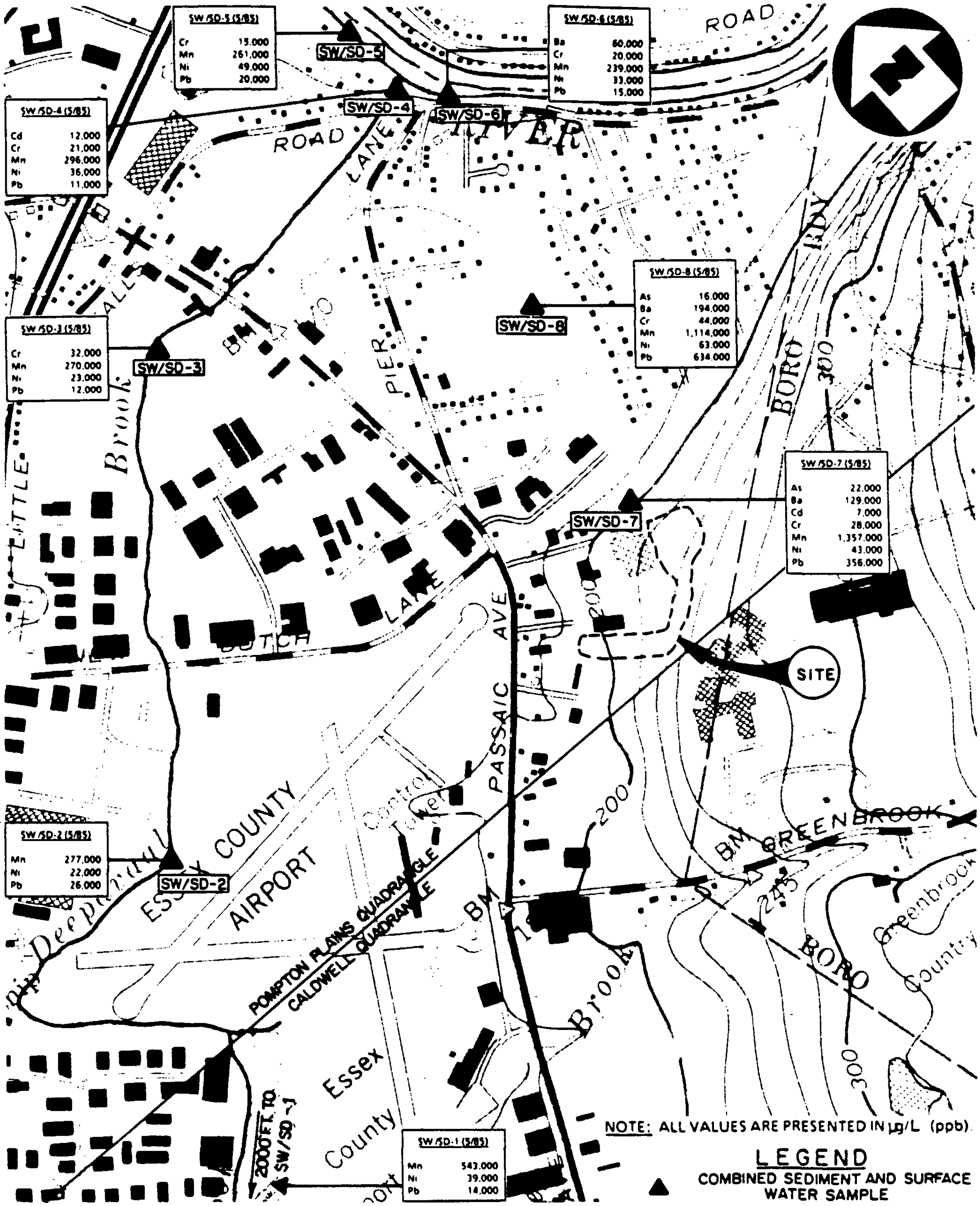

BASE MAP IS AN ENLARGEMENT OF A PORTION OF FIGURE 2-1. SEE FIGURE 7-10 FOR COMPOUND ABBREVIATIONS.

FIGURE 7-4

INORGANIC CONTAMINANT CONCENTRATIONS IN SURFACE WATER
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ
SCALE: 1" = 1000'

NUS CORPORATION
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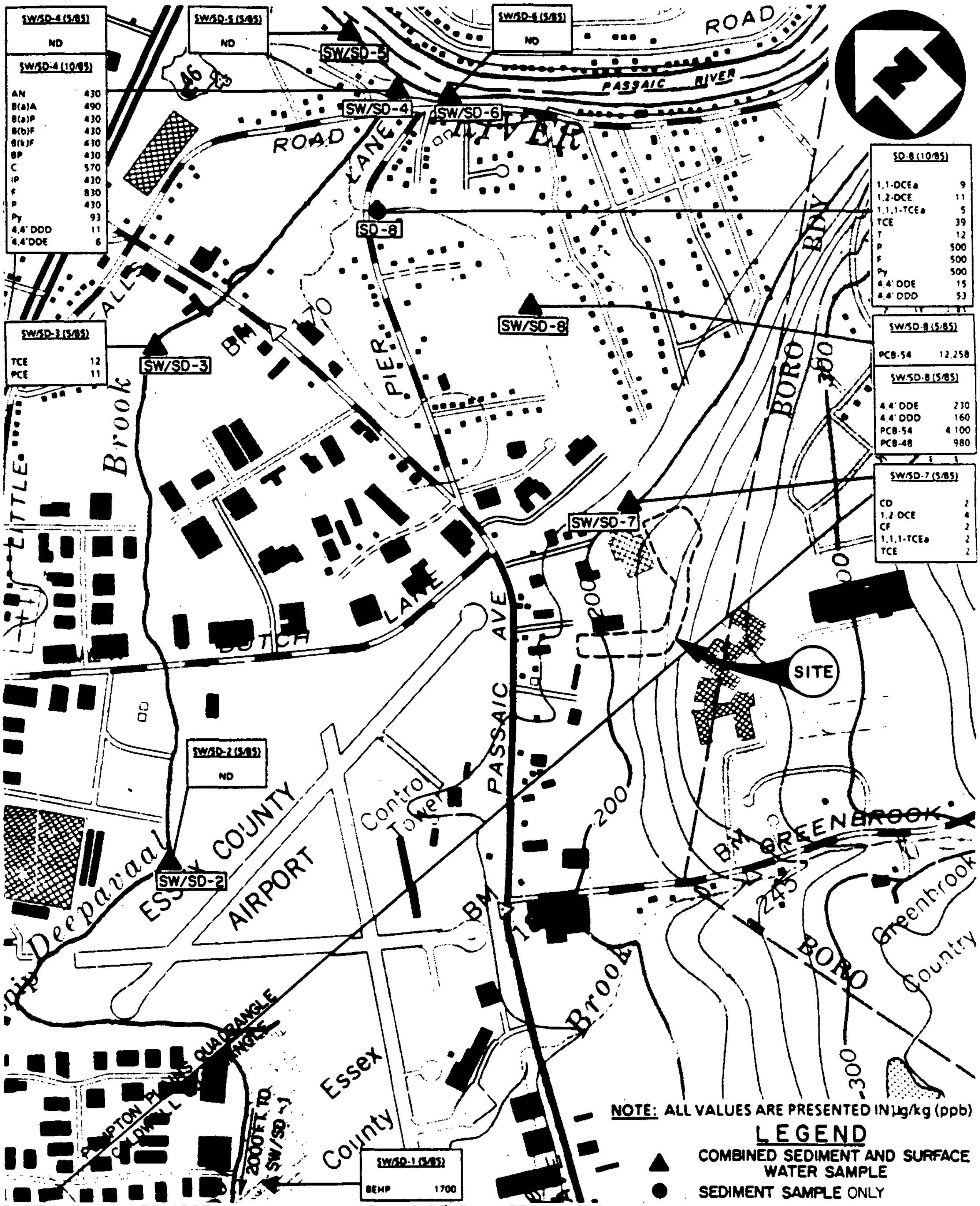
CTC 001 0480



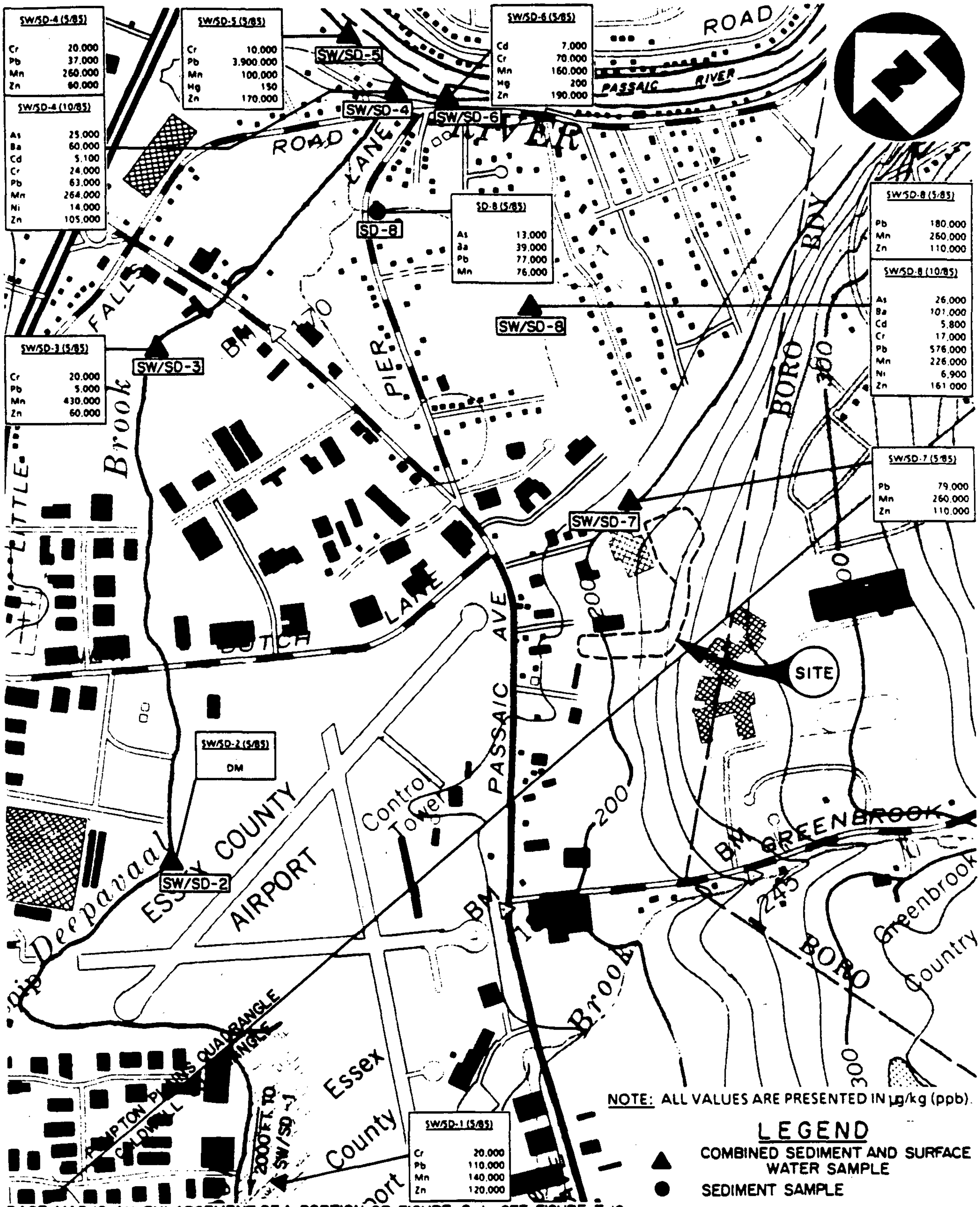
BASE MAP IS AN ENLARGEMENT OF A PORTION OF FIGURE 2-1. SEE FIGURE 7-10 FOR COMPOUND ABBREVIATIONS.

FIGURE 7-5

ORGANIC CONTAMINANT CONCENTRATIONS IN SEDIMENT
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

SCALE: 1" = 1000'

NUS CORPORATION
A Halliburton Company



BASE MAP IS AN ENLARGEMENT OF A PORTION OF FIGURE 2-1. SEE FIGURE 7-10 FOR COMPOUND ABBREVIATIONS.

FIGURE 7-6

INORGANIC CONTAMINANT CONCENTRATIONS IN SEDIMENT
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

SCALE: 1" = 1000'

NUS CORPORATION
A Halliburton Company

CTC 001 0482

soil contaminants in this drainage area. Thus, it is likely that the PCBs at SW/SD-8 originated at the site. A more extensive surface soil sampling program would be necessary to confirm the site as the source of the PCB contamination at SW/SD-8.

Elevated levels of lead, arsenic, and nickel in the surface water of the intermittent stream (SW/SD 7 and 8) also point to site surface soils as the source. Lead concentrations are elevated in site surface samples in the seepage lagoon area, near the stream's source. Nickel and arsenic concentrations are not particularly high in site surface soils, but these are two of the more highly mobile metals, tending to dissolve and stay in solution more readily than the other trace elements. However, these elements may have been bound to particulates as insoluble salts and solubilized only when the sample was acidified as sample preservation prior to shipping to the laboratory. The surface water samples were not filtered prior to being acidified. The surface water concentrations of these elements decrease closer to Deepavaal Brook and the Passaic probably because of both precipitation and dilution.

Volatiles detected in Deepavaal Brook at locations SW/SD 1, 2, and 3 suggest the presence of one or more contamination sources other than Caldwell Trucking Company or General Hose Products, Inc. An industrial survey undertaken by NJDEP enforcement personnel in 1982 revealed that many industries within Fairfield handle the same volatile compounds which have been found in these surface water and sediment samples (NJDEP, January 27, 1983).

Thus, it is felt that volatile contamination found in Deepavaal Brook, downstream of the confluence with the intermittent stream, represents the sum of contamination from both the Caldwell Trucking Company Site area and other unidentified source(s).

CTC 001 0483

7.2.3 Groundwater Migration

The extent of groundwater contamination in the vicinity of the Caldwell Trucking Company Site (as discussed in Section 4.2) is evidence of the mobility of the site contaminants in the local subsurface environment. The volatile organics are the most mobile of the contaminants in the subsurface, primarily because of their ability to dissolve in water. Chemical analytical results show that volatiles are found most frequently and at the highest concentrations in the subsurface soils at the site. Because of their prevalence and inherent mobility, their occurrence is used to assess the extent of migration from the sources on the site. The migration of base/neutral extractable compounds and other compounds in the subsurface in relation to their occurrence is discussed later in this section.

As was discussed earlier, the plume of contamination originating at the site is travelling toward the Passaic River. Chemical/analytical data from samples collected from monitoring wells and residential wells, by both NUS and the NJDEP, are used to estimate the horizontal and lateral extent of the plume. These samples also provide evidence of vertical migration since both glacial till wells and bedrock wells exhibit contamination. Figures 7-7 through 7-10 present contamination detected in upgradient and downgradient wells. The immediate site area is common to both of these figures for ease of comparison.

The local geology facilitates contaminant movement in the subsurface. A rather permeable glacial sediment aquifer consisting of unconsolidated materials including clay, silt, sand, gravel, and boulders overlies fractured basalt bedrock. Contact-metamorphic zones, primarily hornfels, in the deep bedrock are the most highly fractured, water-bearing zones. The glacial sediment aquifer is generally unconfined and hydraulically connected to the fractures in the bedrock. Evidence of this was most prominent at monitoring wells MW-4A and MW-5A (see Section 4.1). Thus, wastes placed in the unlined lagoons at Caldwell Trucking Company, which have been shown to be in close proximity to the bedrock surface, are easily transported via groundwater by both infiltration through the lagoon soil cover and advection in the glacial sediments across the lagoons. An upward

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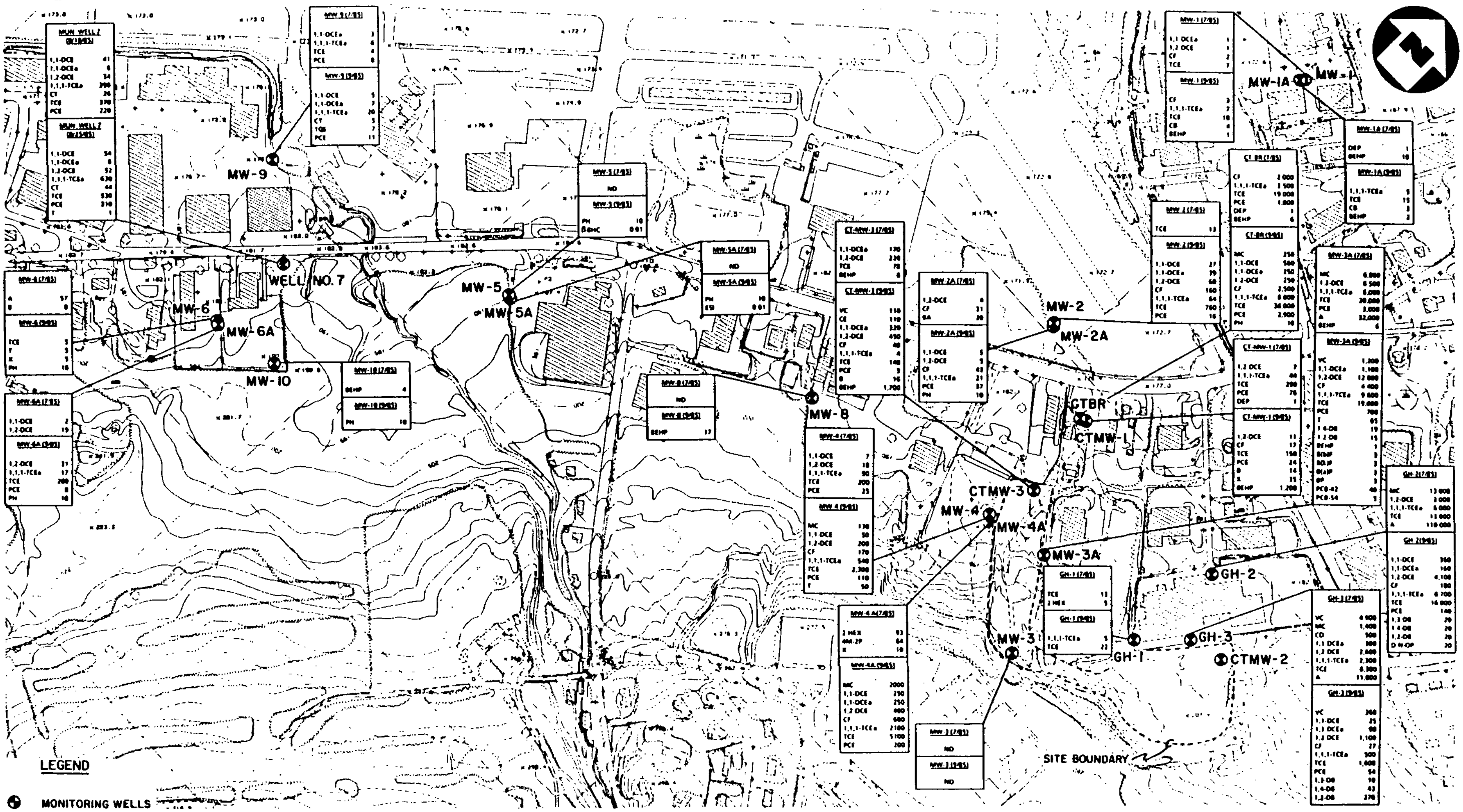

NOTE: ALL VALUES ARE PRESENTED IN $\mu g/L$ (ppb).

COMPOUND ABBREVIATIONS ARE SHOWN IN FIGURE 7-10.

FIGURE 7-7

ORGANIC GROUNDWATER CONTAMINATION IN UPGRADIENT WELLS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

400 0 400
SCALE IN FEET

NUS CORPORATION
A Halliburton Company

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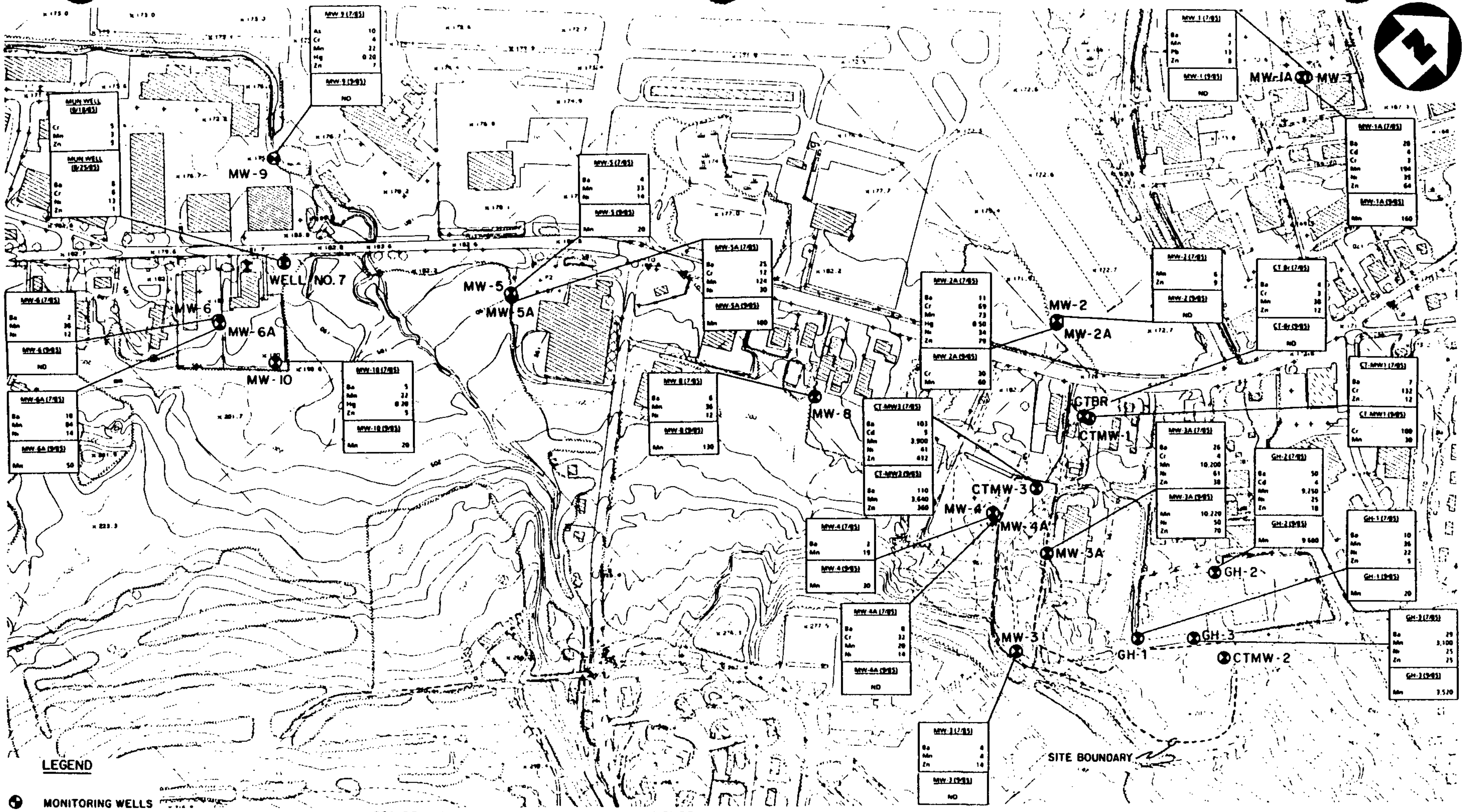


NOTE: ALL VALUES ARE PRESENTED IN $\mu g/L$ (ppb).

COMPOUND ABBREVIATIONS ARE SHOWN IN FIGURE 7-10.

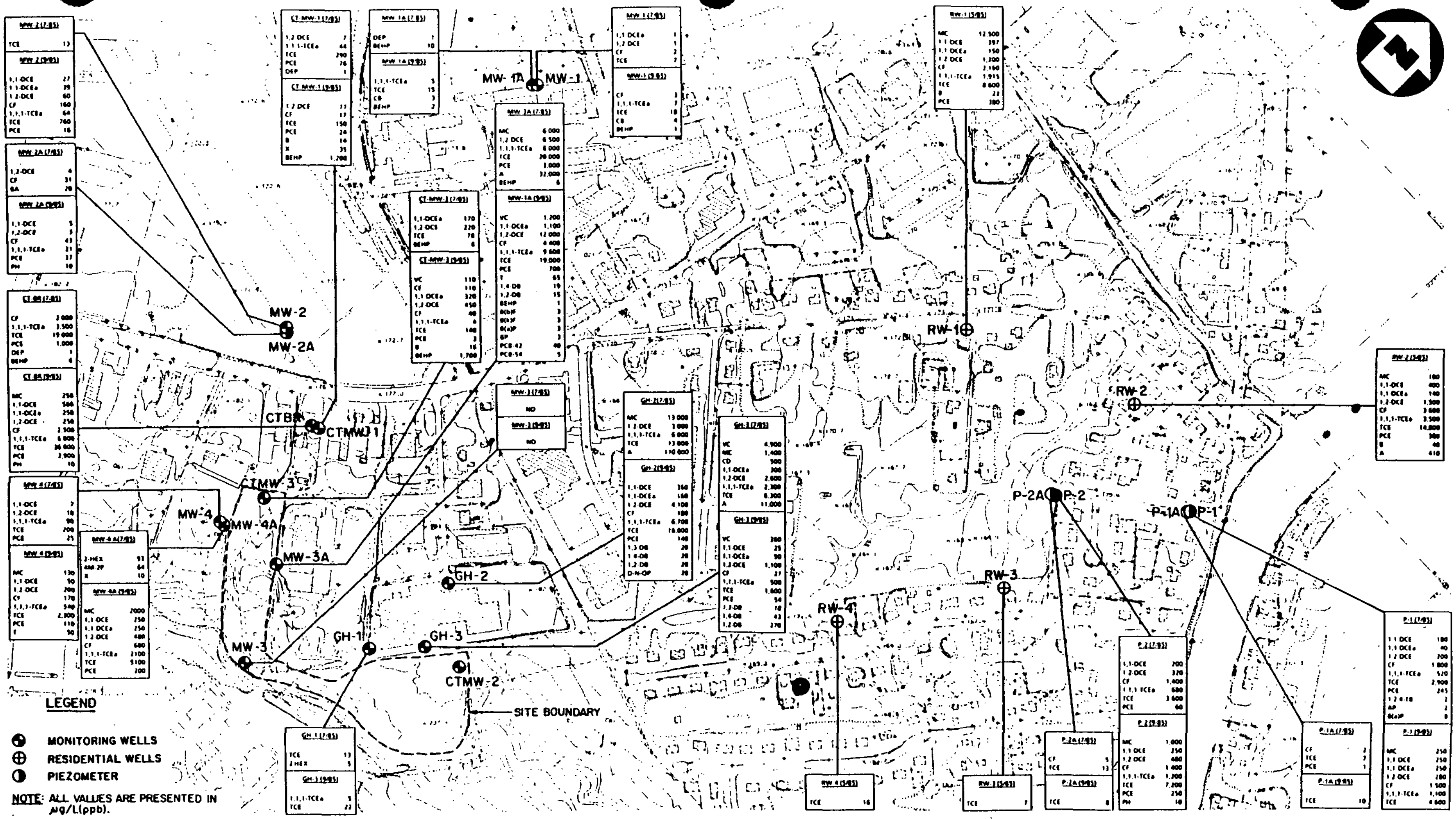
FIGURE 7-8

INORGANIC GROUNDWATER CONTAMINATION IN UPGRADIENT WELLS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

400 0 400
SCALE IN FEET

NUS CORPORATION
A Halliburton Company

CTC 001 0486



COMPOUND ABBREVIATIONS ARE SHOWN IN FIGURE 7-10.

FIGURE 7-9

ORGANIC GROUNDWATER CONTAMINATION IN DOWNGRADIENTS WELLS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

400 0 400
SCALE IN FEET

NUS CORPORATION
A Halliburton Company

CTC 001 0487

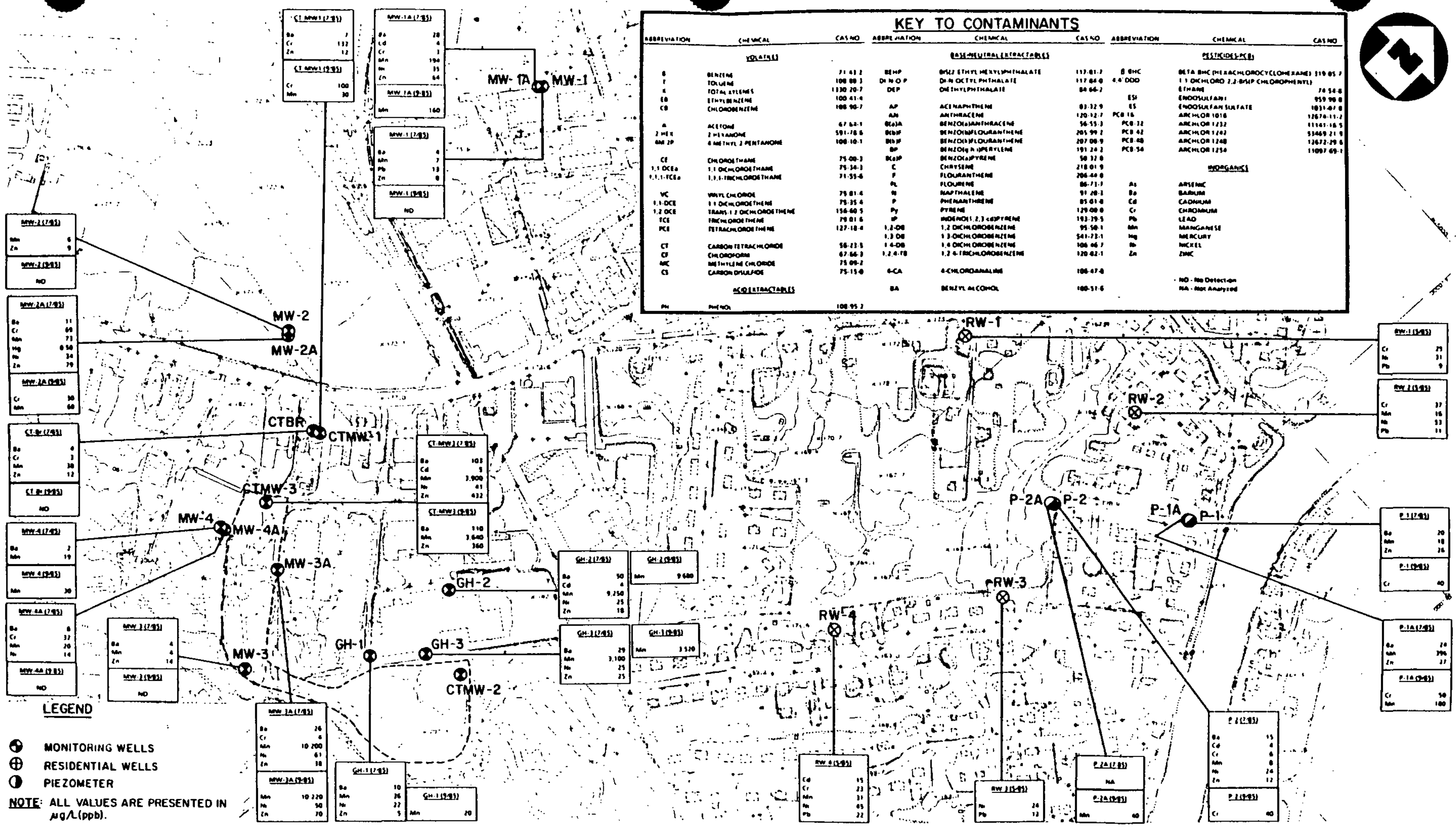


FIGURE 7-10

INORGANIC GROUNDWATER CONTAMINATION IN DOWNGRADIENT WELLS
CALDWELL TRUCKING CO. SITE, FAIRFIELD TWP., NJ

400 0 400
SCALE IN FEET

NUS CORPORATION
A Halliburton Company

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hydraulic gradient between the bedrock and the glacial sediment, indicated by higher water level elevations in wells MW-3 and MW-4 than in glacial sediment wells, may inhibit contamination of the deep rock. However, this upward hydraulic gradient is most likely to be controlled by the highly fractured and permeable hornfels zone intersected by wells MW-3 and MW-4 in the deep bedrock. Thus, contaminant migration into fractures in the shallow basalt is still likely to occur in the immediate vicinity of the lagoons.

Dispersion, or spreading out of the contaminant solute because of mechanical mixing as it is transported by groundwater, causes a reduction in solute concentration over distance. In porous media, like the glacial sediments, longitudinal dispersion (dispersion in the direction of bulk flow) closely mirrors the average groundwater velocity. Some solute molecules travel more rapidly than the average groundwater velocity and some travel more slowly. Longitudinal dispersion is illustrated by the reduction in volatile concentrations between glacial sediment wells adjacent to the site (such as MW-3A) and glacial wells downgradient (like P-1 and P-2). Transverse dispersion (spreading in directions perpendicular to bulk flow) is generally less pronounced than longitudinal dispersion. However, contamination to the north of the site, shown by contamination in wells MW-2, 2A, 1 and 1A is likely to be due to pumping influences in this industrialized area and/or another source of contamination upgradient of these wells.

Fractured geologic materials like the bedrock at the Caldwell Trucking Company Site are generally anisotropic with respect to orientation and frequency of fractures, and make contaminant dispersion unpredictable. In comparison to the glacial sediments, the large travel paths associated with the fractures in the bedrock may produce less of a dispersion related decrease in solute concentration. This may be reflected in the relatively high contaminant concentrations (TVO) in residential wells RW-1 and RW-2, both of which are shallow bedrock wells downgradient of the site. Fractures oriented to the northwest of the site, perpendicular to bulk flow, are indicated by the contamination of well CTBR MW-1 and 2, though the extent of contamination in these wells is probably influenced by the pumping of industrial wells.

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The Unimatic well has a drawdown effect on both glacial wells and bedrock wells in the vicinity of the site (see discussion in Volume II). This cone of depression may increase the level of contamination found in all wells located between the Caldwell Trucking Company Site and the Unimatic well, including the General Hose (GH) wells.

However, well GH-1 exhibits very little contamination in comparison to the other wells in this same area. Water elevation measurements at GH-1 indicate a groundwater mound at this location, which contaminants are evidently skirting. It is likely this mound is created either by increased surface recharge or bedrock discharge in this area, or a less permeable zone in the area.

Contamination in wells GH-2 and GH-3 indicates that the major plume of contamination passes under General Hose, as it migrates toward the Passaic River. Though evidence pinpointing the Caldwell Trucking Company Site as a source of groundwater contamination is overwhelming, additional evidence suggests that General Hose may contribute to the plume. Leaking waste-solvent storage tanks behind General Hose have been shown to be contaminating the soil, and samples from a currently inactive waste disposal system (seepage pits) in this same area have revealed many of the same volatile organics known to be contaminating the groundwater. Soil samples collected from the borehole during the drilling of well GH-3, located adjacent to the waste disposal system, revealed the volatile contamination predominantly at the depth range where these seepage pits were known to be discharging (NJDEP, November 1983). Available data do not afford a quantitative assessment of the extent to which General Hose is adding to the contamination of groundwater.

Analytical data reveal low levels of volatile contamination in wells located approximately 3,300 feet upgradient (southwest) of the site, including the Fairfield Township Well No. 7 (PW-7), though it is unlikely that the source of this contamination is the Caldwell Trucking Company Site. As discussed in Section 4.3.3, the pumping of PW-7 can reverse the local hydraulic gradient from northeast toward the river, to southwest toward PW-7. This effect is illustrated by

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drawdown in wells MW-5 and 5A during pumping of PW-7. However, neither of these wells or MW-8, all located between the site and well PW-7, exhibited any volatile contamination before or after the pumping test. Similar volatile contamination of PW-7, MW-6, MW-6A, and MW-9 points to a source upgradient of these wells. Notably, one volatile compound detected in wells PW-7 and MW-9, carbon tetrachloride, was not detected in any other sampled well near the site or downgradient of the site.

Mechanisms generally known to retard contamination movement in the subsurface are not very effective in retarding the plume of volatiles downgradient of the site. As discussed in Section 8.1, volatile organics do not tend to adsorb to soil or sediments to a significant degree. Also, biological degradation of volatiles is a very slow process and is evidently not a dominant fate of these contaminants in the subsurface here.

However, there is evidence that anaerobic groundwater conditions may degrade trichloroethene and other "parent" chlorinated aliphatic molecules by reductive dehalogenation. This process removes chlorine atoms from 1 and 2 carbon aliphatics. Cline and Viste presented the following degradation mechanism for parent molecules detected at the site (Cline and Viste, 1983):

<u>Chlorinated Ethenes</u>

$$\text{tetrachloroethene} \xrightarrow{\uparrow Cl^-} \text{trichloroethene} \xrightarrow{\uparrow Cl^-} \begin{array}{l}\text{cis-1,2-dichloroethene}\\ \text{trans-1,2-dichloroethene}\\ \text{1,1-dichloroethene}\end{array} \xrightarrow{\uparrow Cl^-} \text{vinyl chloride}$$

<u>Chlorinated Ethanes</u>

$$\text{1,1,1-trichloroethane} \xrightarrow{\uparrow Cl^-} \text{1,1-dichloroethane} \xrightarrow{\uparrow Cl^-} \text{chloroethane}$$

According to Cline & Viste, field studies have shown that the proportions of the degradation products relative to the parent compounds increase with increasing

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distance downgradient of the source. Samples collected during the first round of sampling from heavily contaminated wells near the site, such as MW-3A and CT-BR, contain predominantly the parent chlorinated aliphatics, such as trichloroethene, tetrachloroethene and 1,1,1-trichloroethane. On the other hand, samples collected during the same round from wells approximately 3,500 feet downgradient, such as P1, RW-1 and RW-2, exhibit the parent compounds and the array of degradation products. An important implication of this degradation mechanism is that the chlorinated ethenes may degrade to the potentially more toxic compound, vinyl chloride.

Base/neutral extractable organics and pesticides/PCBs are less mobile in the subsurface than the volatiles. These compounds are less water soluble and more likely to adsorb to soils. As presented in Section 4.5, PCBs were detected often, and in high concentrations in soil borings in the lagoon areas. Yet, unlike the volatiles, the PCB migration in the subsurface is very limited. The single detection of PCBs in groundwater (both Aroclor-1242 and Aroclor-1254) is in well MW-3A, located less than 100 feet downgradient of the lagoons. The occurrence of chlorinated benzenes (1,2-dichloro, 1,3-dichloro, and 1,4-dichloro) exemplifies the subsurface migration capabilities of base/neutral extractable organics. These compounds are more water soluble and less soil adsorptive than the PCBs, but less water soluble and more soil adsorptive than the volatiles. Chlorinated benzenes were detected in wells MW-3A and farther downgradient at wells GH-2 and GH-3, approximately 800 feet from the lagoons. However, wells farther downgradient revealed no chlorinated benzenes or appreciable amounts of other base/neutral extractables. The movement of the base/neutrals and the PCBs in the subsurface is evidently retarded by their adsorption onto soil particles.

Slightly elevated levels of nickel in both monitoring well and residential well samples do not illustrate a pattern like that of the volatile organics. It is difficult to establish whether these nickel concentrations are site related with the current data. Also, the slightly elevated level of cadmium (15 μg/L) in one residential well is anomalous and therefore is thought to be unrelated to the site.

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8.0 PUBLIC HEALTH AND ENVIRONMENTAL CONCERNS

8.1 Introduction

This section presents the assessment of the public health and environmental concerns associated with contamination at the Caldwell Trucking Company Site. The objective of this assessment is to define the actual or potential risks to human health and the environment from the presence of hazardous constituents on and around the site. This assessment will serve as the central element for the evaluation of the need for site remediation.

Risk is a function of toxicity and exposure. For a health or environmental risk to occur several factors must be present; (1) contaminants with toxic characteristics in environmental media, (2) actual or potential exposure pathways, and (3) human or environmental receptors in the exposure pathways. This assessment estimates the potential for human health and environmental risks at the site by combining information on the toxicity of the compounds detected in environmental media and a site-specific determination of exposure probability. The assessment presented in the subsequent sections consists of three components; (1) a Hazard Assessment, (2) an Exposure Assessment, and (3) an estimate of the actual or potential health and environmental risks or Risk Characterization.

8.2 Hazard Assessment

To perform the public health and environmental assessment, it is first necessary to perform a hazard assessment to address the health and environmental implications of the contaminants detected in environmental media. The objectives of the hazard assessment are to determine the nature and extent of the health and environmental hazards associated with exposure to contaminants present at the site. The hazard assessment is a two-step process consisting of a toxicological evaluation and a dose-response evaluation.

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8.2.1 Toxicological Evaluation

Hazardous constituents detected in environmental media at the site include chlorinated aliphatic hydrocarbons, aromatic hydrocarbons, ketones, phthalate esters, nitrosamines, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and inorganics. A discussion of the occurrence and distribution of these compounds was provided in Sections 3.0, 4.0, 5.0, and 6.0. The complete chemical data base is provided in Appendices A and B. All data have been validated as to the performance of the EPA Contract Laboratory Program.

The toxicological evaluation is the process of characterizing the inherent toxicity of these compounds and consists of a review of the scientific data to determine the nature and severity of the health and environmental hazards associated with exposure to the various chemicals. The end product is a toxicity profile which provides the qualitative weight-of-evidence that site associated contaminants pose actual or potential hazards to human health and the environment.

All site-associated contaminants are considered in the quantitative risk assessment in the following sections. However, for the purposes of the toxicological evaluation, toxicity profiles are presented for selected indicator compounds. These compounds have been chosen to represent the most toxic, mobile, and persistant chemicals at the site as well as those detected at the highest concentrations and/or in excess of relevant standards and criteria. These indicator chemicals are assumed to represent the greatest potential public health or environmental concerns.

Indicator compounds selected to assess health and environmental hazards include benzene, 1,1,1-trichloroethane, chloroform, 1,1-dichloroethene, 1,2-trans-dichloroethene, ethylbenzene, methylene chloride, tetrachloroethene, toluene, trichloroethene, xylenes, acetone, PCBs, arsenic, cadmium, lead, and nickel. Most of these compounds were detected in the contaminant plume extending from the

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site, north to the Passaic River. The remaining compounds were selected to assess the hazards associated with human or environmental exposure to contaminated surface waters, sediments, and/or soils.

Toxicity profiles for these compounds are provided in Appendix D. Toxic effects considered in these profiles conclude:

- Threshold health effects - Effects in which a certain dose is required to result in a particular adverse effect. These health effects are defined in terms of the exposure experienced; e.g., acute toxicity - toxic effects after a one-time or short exposure, and chronic toxicity-toxic effects resulting from long-term or repeated exposure. Toxicological endpoints, routes of exposure, and doses in humans and/or animal studies are provided where appropriate.

- Non-threshold health effects - Effects to which any exposure could potentially be associated with adverse health implications. Toxicological endpoints considered include carcinogenicity, mutagenicity, reproductive effects, and/or teratogenicity. Routes of exposure, and doses in humans and/or animal studies are provided.

- Environmental effects - Acute and chronic toxic effects observed in aquatic biota and terrestrial wildlife.

A review of the profiles presented in Appendix D indicates that contaminants detected in environmental media are associated with both non-threshold and threshold health effects in humans and/or experimental animals, and toxic effects in aquatic biota and/or terrestrial wildlife.

The major potential health risk at the site is associated with exposure to known or suspected human or animal carcinogenic compounds. Indicator compounds that are known or suspected carcinogens include benzene, chloroform, 1,1-dichloroethene, methylene chloride, tetrachloroethene, trichloroethene, bis(2-ethylhexyl)phthalate,

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PCBs, arsenic, cadmium, and nickel. Other known or suspected carcinogenic compounds detected in environmental media include several of the polycyclic aromatic hydrocarbons (PAHs), pesticides, and n-nitrosodiphenylamine. All of these compounds are considered in the risk assessment that follows.

Although it is evident that contaminants detected at the site are associated with adverse health and environmental impacts, dose-response relationships and the potential for human exposure must be evaluated before risks to receptors can be determined.

8.2.2 Dose-Response Evaluation

8.2.2.1 Health Effects

An important component of the risk assessment process is the determination of the relationship between the dose (amount of compound to which an individual or population is exposed) and the potential for adverse health effects. Dose-response relationships provide a means by which potential public health impacts may be evaluated. The most applicable information on dose-response relationships are current standards, criteria, and guidelines which provide a quantitative indication of the carcinogenic risk or potential for adverse health impacts (non-threshold effects) associated with environmental exposure.

Table E-1 (Appendix E) lists the standards, criteria, and guidelines for the hazardous constituents detected in environmental media at the Caldwell Trucking Company Site. Dose-response parameters are provided for all contaminants detected in environmental media. A discussion of the assumptions and limitations associated with these parameters follows.

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- Unit Cancer Risk Slope Factor - Carcinogenic risks are estimates of the probability, or range of probabilities, that a specific adverse effect will occur. The unit cancer risk slope factor is defined as the estimated lifetime cancer risk to humans per unit of dose, i.e., the incidence of cancer at a dose of 1 mg/kg of body weight/day for continuous lifetime exposure (Rodricks, 1984). Slope factors based on animal data are the 95 percent upper-bound confidence limit of the carcinogenic potency of the chemical estimated from the linear multi-stage model (i.e., the extrapolation of the non-threshold dose-response relationship observed in animals to the linear, non-threshold dose response relationship in humans). Human slopes are point estimates based on the linear non-threshold model. The unit cancer risk slope factor can be used to convert the estimated dose of a compound to incremental lifetime cancer risk. This factor will be used to estimate the upper-bound incremental lifetime cancer risk associated with potential exposure to site hazardous constituents.

- Maximum Contaminant Levels - Maximum Contaminant Levels (MCLs), promulgated under the Safe Drinking Water Act, are enforceable standards for contaminants in public drinking water supply systems. MCLs are based on lifetime exposure to a contaminant for a 70-kg adult who consumes 2 liters of water per day. MCLs are calculated to reflect exposure to a contaminant from all sources (air, food, water, etc.). They not only consider health factors, but also the economic and technical feasibility of removing a contaminant from a water supply system. The USEPA has recently proposed Recommended MCLs for organic compounds in drinking water. MCLs will be used to evaluate the potential for adverse health impacts associated with ingestion of contaminated groundwater.

- Ambient Water Quality Criteria - Ambient Water Quality Criteria (AWQC) are nonenforceable guidelines for the protection of human health from exposure to contaminants in ambient water. These criteria are

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estimates of the concentration that will not result in adverse health effects in humans, and for known or suspected carcinogens, the concentrations associated with incremental lifetime cancer risks. The AWQC tabulated in Table E-1 are adjusted for the ingestion of drinking water only and assume a 70 kg adult ingests 2 liters of water per day over a 70-year lifetime. AWQC tabulated for ingestion of aquatic biota assume a 70 kg man consumes 6.5 grams of fish per day over a 70-year lifetime. These criteria will be used to evaluate the potential for chronic and carcinogenic health risks associated with ingestion of contaminated drinking water and ingestion of aquatic biota from surface waters contaminated, or potentially contaminated, by site compounds.

- Suggested No Adverse Response Levels - Suggested No Adverse Response Levels (SNARLs) or "Health Advisories" are nonenforceable guidelines, developed by the Office of Drinking Water, for chemicals that may be intermittently encountered in public water supply systems. SNARLs are calculated for a 10 kg child (1 year old infant) who ingests 1 liter of water per day for three exposure levels: 1-day, 10-days, and long term (weeks or months). SNARLs do not consider carcinogenic risks or synergistic effects of chemicals. SNARLs will be used to evaluate the potential for acute and chronic health risks associated with ingestion of contaminated groundwater.

- Acceptable Daily Intakes - Acceptable Daily Intakes (ADIs) are the amount of a toxicant (in mg/day for a 70 kg adult) that is not expected to result in adverse health effects (non-threshold effects) after chronic exposure to the general population (including sensitive subgroups). ADIs are calculated by dividing a quantitative indication of toxicity [i.e., No-Observed Effect Level (NOEL), No-Observed Adverse Effect Level (NOAEL), Lowest-Observed Adverse Effect Level (LOAEL), or Threshold Limit value (TLV)] derived from human or animal toxicity studies, by an

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appropriate uncertainty factor (i.e., 10, 100, and 1,000 depending upon the severity of the biological effect observed in the toxicity studies). A criterion can be developed by dividing an ADI by an appropriate exposure assumption (e.g., ingestion of 2 liters of water per day). ADIs will be used to determine the potential for threshold toxic effects associated with exposure to site hazardous constituents.

8.2.2.2 Environmental Effects

Dose-response relationships for environmental effects are limited to AWQC for the protection of aquatic life. These criteria specify concentrations of a compound in ambient water which, if not exceeded, should protect most aquatic life and its uses. These criteria are derived from both plant and animal data and are developed to protect the types of organisms necessary to support an aquatic community. They consider both acute (short-term) and chronic (long-term) effects. Table E-2 (Appendix E) lists the acute and chronic AWQC for compounds detected in surface waters impacted, or potentially impacted, by site contaminants.

8.3 Exposure Assessment

8.3.1 Introduction

The purpose of this section is to evaluate the potential for human and environmental exposure to hazardous constituents associated with the site. This section identifies actual or potential routes of exposure, characterizes the populations exposed, and evaluates the degree or magnitude of exposure.

To determine if exposure might occur, at present or in the future, the human and environmental activity patterns near the site, and the most likely pathways of chemical release and transport must be defined. A complete exposure pathway has four necessary components: (1) a source of chemical release to the environment, (2) a route of contaminant transport through an environmental medium, (3) an exposure or contact point, and (4) the presence of a human or environmental

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receptor at the exposure or contact point. These components are addressed in the following subsections. In the final subsection, route-specific estimates are provided for the total amount of each contaminant to which a receptor is exposed or potentially exposed, on a daily or periodic basis.

8.3.2 Sources of Contamination and Routes of Transport

The site includes approximately 15 acres centered on facilities of the Caldwell Trucking Company. Historical records indicate domestic and industrial septic tank wastes were placed in several unlined lagoons on the site from the 1940's until 1973. Some of these wastes are believed to contain solvents and other contaminants.

Wastes received by the facility were disinfected in the lagoons with granulated hypochlorite. Sludge from the lagoons was periodically removed and disposed off site. Clarified lagoon water was transported to a disposal pond within the site boundaries and allowed to filter into the subsurface.

The General Hose Products Company, Inc., located adjacent to the site, is also a potential source of contamination. This facility used a number of solvents in its industrial processes. Available data indicate that these materials may have been released by accidental spills as well as discharge through a septic tank and seepage pits. The Caldwell Trucking Company, hauled, temporarily stored, and ultimately disposed of sewage from the General Hose facility.

Sampling and analysis of subsurface media during the RI indicated the presence of wastes contaminated with HSL organic and inorganic compounds. Contaminated surface soils and subsurface soils were also identified. Past operational practices and infiltration of precipitation into the waste have contaminated groundwater and possibly nearby surface waters. The occurrence and distribution of these contaminants are discussed in detail in Sections 3.0, 4.0, and 5.0.

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Chemical and physical characteristics which affect the fate and mobility of the hazardous constituents identified at the site were provided in Section 7.0. A characterization of the potential for contaminant release and migration was also included. Several contaminant transport pathways to human and environmental receptors were identified. A summary to focus the evaluation, follows.

- Contaminant transport via the movement of groundwater under the site. A plume of contaminated groundwater, extending north of the site to the Passaic River in the direction of regional groundwater flow, was identified. Also, pumping tests conducted at the site indicate the potential for alternations in the hydraulic gradient due to local pumping influences.

- Surface water transport of site contaminants. Sampling and analysis of Deepavaal Brook and the unnamed tributary of Deepavaal Brook (located northeast of the site) indicate the presence of site-related HSL organic and inorganic compounds. Deepavaal Brook may have been contaminated by groundwater discharge, although the distribution of contamination along its course suggests that other offsite sources exist in the area. Groundwater discharge to the Passaic River, with subsequent surface water transport, is also a likely route of contamination.

- Contaminated sediment transport via surface water runoff. Surface water runoff could transport contaminated soil particles to the unnamed tributary of Deepavaal Brook, located northeast of the site or other offsite areas. The available chemical analytical data suggests transport by this mechanism has occurred.

Airborne transport of contaminated dusts or evaporation of volatile organic compounds from contaminated surface soil to the ambient air are considered minor routes of contaminant migration. The lack of appreciable surface soil contamination, and the vegetative cover over most areas of the site, suggest

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airborne transport is a minor route of offsite migration of hazardous constituents. Soil disturbance during remedial actions could enhance concentrations to a significant degree.

8.3.3 Identification of Receptors and Routes of Exposure

8.3.3.1 Receptors

Human and environmental receptors that may potentially be exposed to hazardous constituents associated with the site have been identified. These include:

- Local populations - people residing within approximately 1 mile of the site boundaries.

- Distant populations - people residing at a distance (greater than 1 mile) from the site but who may use areas surrounding the site for recreational or work-related purposes. Downstream users of the Passaic River are also considered distant populations.

- Environmental receptors - aquatic flora and fauna in Deepavaal Brook and/or the Passaic River and wildlife and domestic animals that may come into contact with site-associated compounds.

The site is located within a mixed residential, industrial, and commercial area. Within a 1-mile radius there are approximately 530 single family homes. Assuming an average of three to four people per home, approximately 1,590 to 2,120 people live within a 1-mile radius of the site. The closest residential dwellings, excluding the site owner's residence, are located approximately 900 feet northeast of the site.

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Industrial and commercial areas are located south and west of the site. Approximately 45 businesses are located within a 1-mile radius. Local and/or distant populations who utilize these facilities for employment or business purposes may be at risk of exposure.

The Essex Regional High School, attended by approximately 1,800 students in grades 7 through 12, is located approximately 200 feet east of the site. These students may represent a sensitive subgroup of the population.

Preliminary investigations indicate that there are no sensitive or endangered species or critical habitats located within the study area. Biota most likely impacted are common urban terrestrial wildlife and domestic animals.

8.3.3.2 Routes of Exposure

Generally, there are three environmental media by which these receptors may come into contact with contaminants present at the site: groundwater, surface water, and solids (surface soil, sediments, and wastes). Exposure to contaminated media may occur through different routes for local, distant, and environmental receptors.

The mode of exposure influences risks to receptors. Modes of exposure are usually categorized as ingestion, inhalation, and direct contact. Ingestion may take the form of direct exposure through drinking or eating contaminated food and water, or may involve indirect routes such as use of contaminated water for food preparation. Direct inhalation exposure results from breathing air that has become contaminated through volatilization, release of gas-phased contaminants, or entrainment of airborne particulates. Dermal exposure may result from direct contact with contaminated water, soil or other material, or may involve direct contact such as transfer of contaminants from original sources, and subsequent skin contact.

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The following is a media-by-media discussion of the major potential routes of exposure to hazardous constituents associated with the site. This section also identifies local, distant, and/or environmental populations most likely at risk via each potential exposure pathway.

Groundwater

Exposure to contaminated groundwater is the major potential route of human exposure to site-associated contaminants. A plume of contaminated groundwater extends north of the site to the Passaic River in the direction of regional groundwater flow. A discussion of the occurrence and distribution of groundwater contaminants was provided in Section 4.4. Figure 4-15 shows the approximate location of the plume. Figures 7-9 and 7-10 illustrate the extent of HSL organic and inorganic contamination in groundwater downgradient of the site.

Local populations within and surrounding the plume use both municipal water and/or groundwater as potable water supplies. A residential well survey was conducted to characterize groundwater use within the area of the plume. Positive responses to the survey are summarized in Table F-1 (Appendix F).

An analysis of the results indicates the following:

- Residents located in the areas of most contaminated contours of the plume use groundwater for outdoor uses such as garden watering, car washing, etc. Exposure pathways for this group of receptors include occasional, intermittent inhalation, dermal contact, or ingestion exposure associated with nonpotable use of groundwater.

- Residents located at the edge and/or outside of the plume use groundwater as a source of potable drinking water. Potential exposure

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pathways for this group of receptors include frequent, long-term dermal, inhalation, or ingestion exposure.

- Groundwater is used by area businesses for industrial processes. Possible modes of human exposure include inhalation of volatilized contaminants and/or dermal exposure. This pathway is a possible route of exposure for local and distant populations.

Since some residential well questionnaires from the most contaminated areas were not returned, it is not known if any receptors located within the most contaminated areas of the plume use groundwater as a source of potable water. Consequently, the potential for repeated, long-term exposure associated with potable use of the most contaminated groundwater cannot be eliminated.

Receptors located in the vicinity of the site who use groundwater as a source of potable water may be at a potential risk of exposure. A pumping test conducted at Municipal Well No. 7 and pumping influences from other local wells indicate the potential for alterations in the hydraulic gradient. Future increased usage and volume demands could alter the migration of site-associated compounds. Receptors in the vicinity of the site who use groundwater as a potable water supply could potentially be exposed to hazardous constituents via groundwater at some future time.

Volatile organic compounds have been detected in Municipal Well No. 7 and other monitoring wells located upgradient of the site. Figures 7-7 and 7-8 illustrate the extent of HSL organic and inorganic contamination. The detection of these compounds may or may not be site-related. Presently, Municipal Well No. 7 is not used as a potable water supply source.

Subsurface Soils and Wastes

Presently, there is no basis for assessing exposure or risk to onsite subsurface soils. Although these compounds are a source of environmental contamination, the

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potential for direct human or environmental exposure to subsurface contaminants under present site conditions is highly unlikely. A significant degree of soil disturbance at some future time may increase the potential for human and/or environmental exposure.

The potential for exposure to wastes in the existing lagoon is also considered to be minimal. The lagoon is presently covered, limiting the potential for direct contact. Disturbance of site conditions may increase risks to receptors.

Surface Soils and Sediments

Sampling and analysis of onsite and offsite surface soils and sediments indicate the presence of HSL organic and inorganic compounds. Table 4-3 summarizes the occurrence and distribution of surface soil and sediment contaminants. Figures 7-1, 7-2, 7-5 and 7-6 illustrate the extent of contamination. Compounds of concern include chlorinated aliphatic hydrocarbons, aromatic hydrocarbons, PCBs, and lead.

The major potential route of human exposure to contaminated soil and sediments are dermal contact and accidental ingestion.

There are no quantitative data on the size of the population potentially exposed to onsite hazardous constituents via direct contact. Access to the site is not restricted, thus the potential exists for exposure via this route. Receptors entering the site boundaries are at risk.

Receptors most likely to come into direct contact with surface soils are local residents. During RI field activities, children were often observed on site. The site is frequently entered by children who attend the Essex Regional High School. Repeated direct contact with onsite surface soils and sediments is therefore a likely exposure scenario.

Offsite surface soil and sediments are also of concern. Surface water runoff flows to a seasonal, intermittent tributary of Deepavaal Brook, located northeast of the site. Sampling and analysis of sediments indicate the presence of PCBs and low levels of chlorinated aliphatic hydrocarbons. Children who play in and around the creek may be at an increased risk of exposure.

Wildlife and domestic animals may also be exposed to onsite or offsite contaminated soils and sediments. Exposure to these animals is expected to be sporadic and of limited duration. Domestic animals may also carry contaminated sediments or soils to local residences potentially affecting human occupants.

Surface Water

A discussion of the occurrence and distribution of the hazardous constituents detected in surface water samples was provided in Section 5.0. Table 5-1 summarized the compounds detected, the concentration ranges, and the number of positive detections.

Human or environmental exposure to surface water contaminants may occur in the Passaic River, Deepavaal Brook, and/or the unnamed tributary of Deepavaal Brook located northeast of the site.

The potential for human exposure to site-associated compounds in the Passaic River is considered to be minimal. Methylene chloride, a common laboratory contaminant, was the only HSL organic compound detected in the Passaic River immediately downstream of Deepavaal Brook. Exposure to receptors will be minimal because of contaminant attentuation by dilution and volatilization.

However, it is possible that the contaminant plume may impact the river via groundwater recharge. Subsequently, to estimate the magnitude of human or environmental exposure, the concentrations of hazardous constituents in the Passaic River were estimated (using Dupuit's formula) under low flow and average flow conditions to characterize "worst-case" exposure scenario. Table 8-1 lists the

TABLE 8-1

ESTIMATED CONCENTRATIONS OF CONTAMINANTS IN THE PASSAIC RIVER CALDWELL TRUCKING COMPANY SITE

Contaminant	Well Location	Sampling Round	Maximum Concentration in Piezometers (μg/l)	Predicted Contaminant Concentration in the River (μg/l)		Average Predicted Contaminant Concentration in the River (μg/l)	
				Low Flow	Average Flow	Low Flow	Average Flow
methylene chloride	P-1	2	250	0.124	0.005	0.145	0.006
	P-2	2	1,000	0.166	0.006		
1,1-dichloroethene	P-1	2	250	0.124	0.005	0.083	0.004
	P-2	2	250	0.041	0.002		
1,1-dichloroethane	P-1	2	250	0.124	0.005	0.124	0.005
	P-2	--	ND	--	--		
trans-1,2-dichloroethene	P-1	2	280	0.139	0.005	0.110	0.004
	P-2	2	480	0.080	0.003		
chloroform	P-1	1	1,800	0.895	0.033	0.564	0.021
	P-2	1	1,400	0.232	0.009		
1,1,1-trichloroethane	P-1	2	1,100	0.547	0.020	0.373	0.014
	P-2	2	1,200	0.199	0.007		
trichloroethene	P-1	2	4,600	2.286	0.085	1.740	0.065
	P-2	2	7,200	1.193	0.045		
tetrachloroethene	P-1	1	245	0.122	0.005	0.082	0.004
	P-2	2	250	0.041	0.002		
1,2,4-trichlorobenzene	P-1	1	2	0.001	3.71×10^{-5}	0.001	3.7×10^{-5}
	P-2	--	ND	--	--		
acenaphthene	P-1	1	2	0.001	3.71×10^{-5}	0.001	3.71×10^{-5}
	P-2	--	ND	--	--		
benzo(a)pyrene	P-1	1	8	0.004	1.49×10^{-4}	0.004	1.49×10^{-4}
	P-2	--	ND	--	--		
phenol	P-1	--	ND	--	--		
	P-2	2	10	0.002	6.19×10^{-5}	0.002	6.19×10^{-5}

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Notes:

ND = Not Detected
Assumptions and sample calculations are provided in Appendix G.

estimated river concentrations due to plume loading in the Passaic River. Site-specific assumptions and sample calculations are provided in Appendix G.

The Passaic River is classified by the New Jersey Department of Environmental Protection as a FW2 nontrout surface water (Sarhnca, 1986). These surface waters are suitable for public potable water supply, the maintenance migration and propagation of biota, primary contact recreation, and industrial and agricultural water supply (New Jersey Surface Water Quality Standards, 1981).

Human exposure may occur during recreational use. Boating on the river was observed during RI activities. Dermal contact and/or accidental ingestion during swimming, boating, or other recreational activities are possible routes of exposure for local and/or distant populations. Local populations, particularly children who come to the river's edge and play or wade in the river, may come into contact with contaminated river water.

Ingestion of contaminated biota, if site-associated compounds bioaccumulate in the tissues of exposed organisms, is also a potential route of exposure for local and/or distant populations. Shad and herring, common food fish, are present in the river.

Distant populations, located downstream of the site, who use the Passaic River as a source of potable water may be exposed via ingestion. The Passaic Valley Water Commission potable water supply intake is located 2.2 miles downstream of Deepavaal Brook. Water is supplied to approximately 750,000 customers in downstream communities. Ingestion of site-associated compounds in the Passaic River is considered a very minor route of human exposure.

Local and/or distant populations may also be exposed to site-related HSL compounds in Deepavaal Brook. Low levels of volatile organic compounds were detected in surface water samples. A stream classification for Deepavaal Brook is not available, although it is mostly likely classified as FW2 nontrout (Sarhnca, 1986). Human exposure to hazardous constituents may occur via accidental ingestion or direct contact. These routes of exposure may be significant

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for local populations, particularly children and/or teenagers, who may wade or play in the water. Exposure via ingestion of fish from Deepavaal Brook is also possible.

Exposure to contaminated surface water in the unnamed tributary of Deepavaal Brook is considered a potential exposure pathway. Receptors who wade or play in and around the creek may be at an increased risk of exposure. Intermittent, seasonal flow would limit the magnitude and duration of human contact. Of major concern are children who may come into contact with contaminated surface waters on a daily basis.

Environmental receptors may also be exposed to hazardous constituents in surface waters. Wild and domestic animals may frequent potentially impacted surface waters to wade or bathe. Because these populations may easily gain access to the Passaic River or Deepavaal Brook, they could potentially come into contact with site-associated contaminants. Their exposure is expected to be sporadic and of short duration. Aquatic flora and fauna inhabiting site-impacted surface waters are also likely to be exposed.

Ambient Air

Under present site conditions, inhalation of airborne contaminated dusts and/or inhalation of volatilized surface soil contaminants are considered to be very minor routes of human or environmental exposure. Surface soils are not appreciably contaminated with volatile organic compounds. Also, the vegetative cover over most areas of the site would limit the emission of airborne particulates. Hazardous constituents entering the ambient air would rapidly disperse.

A significant degree of soil disturbance is likely to increase ambient air concentrations. Air sampling conducted during RI subsurface investigations indicate the presence of low levels of methylene chloride, acetone, 1,2-trans-dichloroethene, methyl ethyl ketone, 1,1,1-trichloroethane, trichloroethene, benzene, tetrachloroethene, toluene, and ethylbenzene following soil disturbance. Concentrations decrease with increasing distance from the source.

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Exposures and possible health risks associated with inhalation during various possible soil disturbance scenarios will be addressed in the Feasibility Study.

Summary

The preceding discussion identified human and environmental exposure pathways of concern. A summary is presented to focus the evaluation. The major potential routes of exposure to local and/or distant populations are:

- Ingestion of contaminated groundwater downgradient of the site. Domestic uses of groundwater (showering, bathing, etc.) may also constitute a significant route of exposure.

- Direct contact exposure, accidental ingestion, or inhalation associated with the use of groundwater for nonpotable purposes such as lawn watering, car washing, or industrial processes.

- Direct contact with contaminated surface soil on site and/or soils and sediments adjacent to the site that may have been contaminated by surface water runoff or erosion processes. Direct contact includes dermal exposure as well as accidental ingestion.

- Dermal contact with or accidental ingestion of surface water in the Passaic River, Deepavaal Brook, and/or the unnamed tributary of Deepavaal Brook located northeast of the site.

- Ingestion of contaminated biota (fish) from the Passaic River or Deepavaal Brook if contaminants bioaccumulate in the tissues of exposed organisms.

- Ingestion of contaminants in the Passaic River which is used as a water supply for communities down river of the site.

CTC 001 0513

The major potential routes of exposure to environmental receptors are:

- Terrestrial Biota - Direct contact, inhalation, or ingestion of contaminated surface water, sediments, and soils.

- Aquatic Biota - Potential exposure associated with hazardous constituents in Deepavaal Brook and the Passaic River.

8.3.4 Characterization of Exposure

Section 8.3.3 identified human receptors and exposure pathways of concern. The final step in conducting an exposure assessment requires a quantitative determination of the dose of contaminants incurred by those receptors. This section provides route-specific estimates of the total amount of each contaminant to which a receptor is exposed, or potentially exposed, on a daily basis. Dose estimates are limited to all organic compounds detected in environmental media for which dose-response relationships [Acceptable Daily Intakes (ADIs) or Unit Cancer Risk Slope Factors (UCRs)] presented in Section 8.2.2, have been established. Although inorganic compounds are considered in the risk assessment, the inability to determine the form or valence state precludes estimation of exposure levels for these compounds.

A dose is defined as the amount of a compound (mg) absorbed by a receptor on a daily basis per kilogram of body weight. Doses can be calculated for lifetime or less than lifetime exposures. A dose can be estimated as follows:

$$\text{Dose} = \frac{\text{Concentration in an Environmental Medium} \times \text{Contact Rate} \times \text{Exposure Duration} \times \text{Absorbed Fraction}}{\text{Body Weight}}$$

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8.3.4.1 Groundwater Route

Ingestion

The types and concentrations of hazardous constituents in residential well samples are considered to adequately characterize the potential health risks associated with exposure to contaminated groundwater in the contaminant plume. Consequently, the results of the residential well sampling and analysis are to be used to estimate potential exposures.

It must be emphasized that not all receptors are exposed to hazardous constituents in drinking water. Residential well RW-001 is used for outdoor purposes such as car washing, lawn watering, etc. Municipal water is used as a potable water supply source by this receptor. Two residential well questionnaires were returned for RW-002 (18 Toll Terrace). The first questionnaire indicated that groundwater was used as a potable water supply source. The second questionnaire indicated groundwater is used only for outdoor purposes. Residential wells RW-003 and RW-004 are used as a potable water supply source. Consequently, to characterize possible "worst-case" exposure scenarios, all residential well sample results are considered for each possible exposure pathway.

The maximum potential exposures associated with long-term ingestion of contaminated groundwater in the residential wells (contaminant plume) are listed in Table 8-2. Dose estimates are provided for all compounds for which ADIs or UCRs are available. The estimated doses assume a 70-kg man ingest 2 liters of water per day. Sample calculations are provided in Appendix G.

Ingestion of contaminated groundwater upgradient of the site is also of concern. Table 8-3 lists the estimated doses associated with long-term ingestion of the average and maximum concentrations of contaminants detected in Municipal Well No. 7. Although Municipal Well No. 7 is presently not used as a potable water supply source, dose estimates are provided to characterize potential risks to upgradient receptors. Dose estimates are provided for all contaminants for which

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TABLE 8-2

DOSE ESTIMATES
INGESTION OF CONTAMINATED GROUNDWATER - CONTAMINANT PLUME
CALDWELL TRUCKING COMPANY SITE

Compound	Estimated Dose/Person (mg/kg-day)			
	RW-001	RW-002	RW-003	RW-004
Noncarcinogens				
acetone	ND	0.01 @400 μg/l	ND	ND
1,1-dichloroethane	0.004 @150 μg/l	0.004 @140 μg/l	ND	ND
1,1,1-trichloroethane	0.05 @1,915 μg/l	0.10 @3,500 μg/l	ND	ND
Known or Suspected Carcinogens				
benzene	6.3×10^{-4} @22 μg/l	1.1×10^{-3} @40 μg/l	ND	ND
methylene chloride	0.36 @12,500 μg/l	5.1×10^{-3} @180 μg/l	ND	ND
1,1-dichloroethene	0.011 @397 μg/l	0.011 @400 μg/l	ND	ND
chloroform	0.09 @3,160 μg/l	0.10 @3,600 μg/l	ND	ND
trichloroethene	0.24 @8,600 μg/l	0.4 @14,000 μg/l	2.1×10^{-4} @ 7.4 μg/l	4.6×10^{-4} @ 16 μg/l
tetrachloroethene	0.01 @380 μg/l	0.01 @380 μg/l	ND	ND

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Notes:

Consider samples RW-001 through RW-004
Sample calculations are provided in Appendix G.
ND: Not Detected

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TABLE 8-3

DOSE ESTIMATES
INGESTION OF CONTAMINATED GROUNDWATER - MUNICIPAL WELL NO. 7
CALDWELL TRUCKING COMPANY SITE

Compound	Estimated Dose/Person (mg/kg-day) Average Concentration (2)			Maximum Concentration (1)		
Noncarcinogens						
1,1-dichloroethane	1.7×10^{-4}	@	6 ug/l	1.7×10^{-4}	@	6 ug/l
1,1,1-trichloroethane	0.015	@	510 ug/l	0.018	@	630 ug/l
toluene	1.4×10^{-5}	@	0.5 ug/l	2.9×10^{-5}	@	1 ug/l
Known or Suspected Carcinogens						
carbon tetrachloride	1.0×10^{-3}	@	35 ug/l	1.3×10^{-3}	@	44 ug/l
1,1-dichloroethene	1.3×10^{-3}	@	47.5 ug/l	1.5×10^{-3}	@	54 ug/l
trichloroethene	0.013	@	450 ug/l	0.015	@	530 ug/l
tetrachloroethene	7.6×10^{-3}	@	265 ug/l	8.9×10^{-3}	@	310 ug/l

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Notes:

Sample calculations are provided in Appendix G.
Consider samples MW-001 through MW-002
Dose estimates do not consider contaminant attenuation in the water supply distribution system

ADIs or UCRs are available. The dose estimates presented in Table 8-3 assume a 70 Kg man ingests 2 liters of water per day. The estimates do not consider contaminant attenuation (dilution or degradation) in the distribution system.

Inhalation

Domestic use of contaminated groundwater can contribute to the total dose a receptor may receive. Inhalation of volatile organic contaminants during showering can constitute a significant, quantifiable route of human exposure.

To estimate a dose or daily exposure associated with inhalation, several assumptions are made (Andelman, 1985; USEPA, 1985). These include

- 190 liters of water are used during showering
- 50 percent of the contaminant volatilizes to the air
- 0.33 hr/day is spent in the bathroom
- 1.2 m^3/hr are inhaled
- The estimated dimensions of a bathroom are 12 m^3
- 100 percent of the compound is absorbed upon entering the lungs
- The weight of an adult is 70 kg

Using these assumptions, doses associated with inhalation during showering were calculated for the volatile organic compounds detected in residential well samples. The results are shown in Table 8-4. Table 8-5 lists the doses associated with inhalation of the average and maximum concentrations of volatile organic compounds detected in Municipal Well No. 7. Sample calculations are provided in Appendix G.

Non-Potable Uses

No quantitative data are available to estimate exposures associated with dermal, inhalation, or ingestion of contaminated groundwater during activities such as car washing, lawn watering, or industrial use. The degree of exposure depends on

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TABLE 8-4

DOSE ESTIMATES
INHALATION DURING SHOWERING - CONTAMINANT PLUME
CALDWELL TRUCKING COMPANY SITE

Compound	Estimated Dose/Person (mg/kg-day)							
	RW-001		RW-002		RW-003		RW-004	
Noncarcinogens								
acetone	ND		0.0179	@140 µg/l	ND		ND	
1,1-dichloroethane	0.007	@150 µg/l	0.006	@400 µg/l	ND		ND	
1,1,1-trichloroethane	0.09	@1,915 µg/l	0.156	@3,500 µg/l	ND		ND	
Known or Suspected Carcinogens								
benzene	9.8×10^{-4}	@22 µg/l	1.8×10^{-3}	@40 µg/l	ND		ND	
methylene chloride	0.56	@12,500 µg/l	8.1×10^{-3}	@180 µg/l	ND		ND	
1,1-dichloroethene	0.018	@397 µg/l	0.018	@400 µg/l	ND		ND	
chloroform	0.14	@3,160 µg/l	0.16	@3,600 µg/l	ND		ND	
trichloroethene	0.38	@8,600 µg/l	0.627	@14,000 µg/l	3.3×10^{-4}	@7.4 µg/l	7.2×10^{-4}	@16 µg/l
tetrachloroethene	0.017	@380 µg/l	0.017	@380 µg/l	ND		ND	

Notes:

Sample calculations are provided in Appendix G.
ND: Not Detected

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TABLE 8-5

DOSE ESTIMATES
INHALATION DURING SHOWERING – MUNICIPAL WELL NO. 7
CALDWELL TRUCKING COMPANY SITE

Compound	Estimated Dose/Person (mg/kg-day): Average Concentration	Estimated Dose/Person (mg/kg-day): Maximum Concentration
Noncarcinogens		
1,1-dichloroethane	2.7×10^{-4} @ 6 ug/l	2.7×10^{-4} @ 6 ug/l
1,1,1-trichloroethane	0.023 @ 510 ug/l	0.028 @ 630 ug/l
toluene	2.2×10^{-5} @ 0.5 ug/l	4.5×10^{-5} @ 1 ug/l
Known or Suspected Carcinogens		
carbon tetrachloride	1.6×10^{-3} @ 35 ug/l	2.0×10^{-3} @ 44 ug/l
1,1-dichloroethene	2.1×10^{-3} @ 47.5 ug/l	2.4×10^{-3} @ 54 ug/l
trichloroethene	0.02 @ 450 ug/l	0.024 @ 530 ug/l
tetrachloroethene	0.012 @ 265 ug/l	0.014 @ 310 ug/l

Notes:

Sample calculations are provided in Appendix G.
Consider samples MW7-001 through MW7-002
Does not consider contaminant attenuation in the water supply distribution system

CTC 001 0520

human activity patterns and factors such as the frequency and duration of exposure. However, it is likely that these pathways are significant routes of human exposure to site-associated hazardous constituents.

8.3.4.2 Wastes

Dermal Contact and Accidental Ingestion

Presently, there is no basis for assessing exposure to contaminated subsurface soils and subsurface wastes. However, there is a potential for direct contact exposures (accidental ingestion and direct contact) with wastes present in the existing lagoon.

Assumptions used to estimate the "worst-case" dose associated with dermal contact include

- A lifetime soil accumulation ranges from 7,900 grams to 110,000 grams (Schaum, 1984).

- One hundred percent of a compound is absorbed through the skin (McLaughlin, 1984). Ten percent of the pesticides are absorbed through the skin (McLaughlin, 1984).

- The weight of an adult is 70 kg.

- An expected lifetime is 70 years.

Assumptions used to estimate the "worst-case" dose associated with accidental ingestion of wastes and contaminated soils include

- An exposure duration ranges from 1,240 to 1,830 days (Schaum, 1984).

- 0.1 to 5 g of soil are ingested per day (Schaum, 1984).

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- 100 percent of the compound is absorbed through the gastrointestinal tract.

- The weight of a child (2 to 6 years old) likely to ingest soil is 14 kg (Schaum, 1984).

- An expected lifetime is 70 years.

Tables 8-6 and 8-7 list the estimated doses associated with dermal exposure and accidental ingestion of wastes in the existing lagoon. Sample calculations are provided in Appendix G.

8.3.4.3 Soil Route

Dermal Contact and Accidental Ingestion

Dermal contact or accidental ingestion of soil can be significant routes of human exposure to site associated compounds. The degree of exposure is dependent upon human activity patterns on or near the site and factors such as amount of skin exposure, duration of contact, and soil conditions.

Tables 8-8 through 8-11 list the doses associated with direct contact to onsite and offsite surface soil and sediment contaminants. (Doses calculated separately for the north lagoon and the central lagoon area are provided in Appendix H). Doses are calculated for the average and maximum concentrations to provide a range of exposure estimates. Dose estimates for exposure to offsite soils and sediments are limited to HSL organic compounds detected in the intermittent tributary of Deepavaal Brook located north of the site.

All detected compounds (i.e., compounds with ADIs or UCRs) were considered in the estimation of onsite and/or offsite exposures except the PAHs detected in samples SD-101, SO-015, SD-108a, SD-108, and SD-109. Higher concentrations of PAHs were detected in these samples than in samples from onsite surface soil

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TABLE 8-6

DOSE ESTIMATES
DERMAL EXPOSURE TO WASTES IN THE EXISTING LAGOON
CALDWELL TRUCKING COMPANY SITE

	Estimated Dose/Person (mg/kg-day)(1)			
	Average Soil Concentration(2)		Maximum Soil Concentration	
Compound	Minimum Lifetime Soil Accumulation(3)	Maximum Lifetime Soil Accumulation(4)	Minimum Lifetime Soil Accumulation(3)	Maximum Lifetime Soil Accumulation(4)
Noncarcinogens				
acetone	2.1×10^{-7} @ 48.6 ug/kg	3.0×10^{-6} @ 48.6 ug/kg	1.5×10^{-6} @ 340 ug/kg	2.1×10^{-5} @ 340 ug/kg
chlorobenzene	9.7×10^{-7} @ 221.4 ug/kg	1.4×10^{-6} @ 221.4 ug/kg	3.5×10^{-6} @ 790 ug/kg	4.9×10^{-5} @ 790 ug/kg
1,1-dichloroethane	5.8×10^{-8} @ 13.1 ug/kg	8.1×10^{-7} @ 13.1 ug/kg	4.0×10^{-7} @ 92 ug/kg	5.7×10^{-6} @ 92 ug/kg
ethylbenzene	5.8×10^{-8} @ 13.1 ug/kg	8.1×10^{-7} @ 13.1 ug/kg	4.0×10^{-7} @ 92 ug/kg	5.7×10^{-6} @ 92 ug/kg
xylenes	6.8×10^{-8} @ 15.4 ug/kg	9.5×10^{-7} @ 15.4 ug/kg	4.0×10^{-7} @ 92 ug/kg	5.7×10^{-6} @ 92 ug/kg
1,2-dichlorobenzene	1.7×10^{-6} @ 382.8 ug/kg	2.4×10^{-5} @ 382.8 ug/kg	8.4×10^{-6} @ 61,900 ug/kg	1.2×10^{-4} @ 1,900 ug/kg
1,3-dichlorobenzene	2.8×10^{-6} @ 637 ug/kg	3.9×10^{-5} @ 637 ug/kg	1.1×10^{-5} @ 2,400 ug/kg	1.5×10^{-4} @ 2,400 ug/kg
1,4-dichlorobenzene	2.5×10^{-6} @ 571.4 ug/kg	3.5×10^{-5} @ 571.4 ug/kg	1.3×10^{-5} @ 2,900 ug/kg	1.8×10^{-4} @ 2,900 ug/kg
fluoranthene	3.2×10^{-6} @ 737 ug/kg	4.5×10^{-5} @ 734 ug/kg	1.2×10^{-5} @ 2,700 ug/kg	1.7×10^{-4} @ 2,700 ug/kg
naphthalene	2.9×10^{-6} @ 664.3 ug/kg	4.1×10^{-5} @ 664.3 ug/kg	8.4×10^{-6} @ 1,900 ug/kg	1.2×10^{-4} @ 1,900 ug/kg
1,2,4-trichlorobenzene	6.2×10^{-7} @ 14 ug/kg	8.6×10^{-6} @ 14 ug/kg	4.3×10^{-6} @ 980 ug/kg	6.0×10^{-5} @ 980 ug/kg
bis(2-ethylhexyl)phthalate(5)	6.1×10^{-5} @ 13,857 ug/kg	8.5×10^{-4} @ 13,857 ug/kg	4.3×10^{-4} @ 97,000 ug/kg	6.0×10^{-3} @ 97,000 ug/kg
Known or Suspected Carcinogens				
benzene	7.9×10^{-8} @ 18 ug/kg	1.1×10^{-6} @ 18 ug/kg	4.0×10^{-7} @ 92 ug/kg	5.7×10^{-6} @ 92 ug/kg
chloroform	2.4×10^{-8} @ 5.4 ug/kg	3.3×10^{-7} @ 5.4 ug/kg	1.4×10^{-7} @ 32 ug/kg	2.0×10^{-6} @ 32 ug/kg
methylene chloride	2.3×10^{-7} @ 53 ug/kg	3.3×10^{-6} @ 53 ug/kg	1.6×10^{-6} @ 370 ug/kg	2.3×10^{-5} @ 370 ug/kg
vinyl chloride	1.1×10^{-7} @ 26 ug/kg	1.6×10^{-6} @ 26 ug/kg	7.9×10^{-7} @ 180 ug/kg	1.1×10^{-5} @ 180 ug/kg
tetrachloroethene	7.5×10^{-9} @ 1.7 ug/kg	1.0×10^{-7} @ 1.7 ug/kg	5.3×10^{-8} @ 12 ug/kg	7.4×10^{-7} @ 12 ug/kg
PCB-1016	1.5×10^{-5} @ 3485.7 ug/kg	2.1×10^{-4} @ 3485.7 ug/kg	6.2×10^{-5} @ 14,000 ug/kg	8.6×10^{-4} @ 14,000 ug/kg
PCB-1254	1.0×10^{-7} @ 22.9 ug/kg	1.4×10^{-6} @ 22.9 ug/kg	3.5×10^{-7} @ 80 ug/kg	4.9×10^{-6} @ 80 ug/kg

Notes:
(1) Considers samples SL-001 through SL-004, SS-002 and SS-003.
(2) Calculation of the average concentration includes nondetections.
(3) The minimum estimated lifetime soil accumulation is 7,900 g (Schaum, 1984).
(4) The maximum estimated lifetime soil accumulation is 110,000 g (Schaum, 1984).
(5) Does not consider carcinogenic effects of bis(2-ethylhexyl)phthalate.
Sample calculations are provided in Appendix G.

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TABLE 8-7

DOSE ESTIMATES
ACCIDENTAL INGESTION OF WASTES IN THE EXISTING LAGOON
CALDWELL TRUCKING COMPANY SITE

	Estimated Dose/Person (mg/kg-day)[1]			
	Average Waste Concentration[2]		Maximum Waste Concentration	
Compound	Minimum Soil Ingestion Rate[3]	Maximum Soil Ingestion Rate[4]	Minimum Soil Ingestion Rate[3]	Maximum Soil Ingestion Rate[4]
Noncarcinogens				
acetone	3.5×10^{-7} @ 48.6 ug/kg	1.7×10^{-5} @ 48.6 ug/kg	2.4×10^{-6} @ 340 ug/kg	1.2×10^{-4} @ 340 ug/kg
chlorobenzene	1.6×10^{-6} @ 221.4 ug/kg	8.0×10^{-5} @ 221.4 ug/kg	5.6×10^{-6} @ 790 ug/kg	2.8×10^{-4} @ 790 ug/kg
1,1-dichloroethane	9.3×10^{-8} @ 13.1 ug/kg	4.7×10^{-6} @ 13.1 ug/kg	6.5×10^{-7} @ 92 ug/kg	3.3×10^{-5} @ 92 ug/kg
ethylbenzene	9.3×10^{-8} @ 13.1 ug/kg	4.7×10^{-6} @ 13.1 ug/kg	6.5×10^{-7} @ 92 ug/kg	3.3×10^{-5} @ 92 ug/kg
xylenes	1.1×10^{-7} @ 15.4 ug/kg	5.5×10^{-6} @ 15.4 ug/kg	6.5×10^{-7} @ 92 ug/kg	3.3×10^{-5} @ 92 ug/kg
1,2-dichlorobenzene	2.7×10^{-6} @ 382.8 ug/kg	1.4×10^{-4} @ 382.8 ug/kg	1.3×10^{-5} @ 61,900 ug/kg	6.8×10^{-4} @ 1,900 ug/kg
1,3-dichlorobenzene	4.5×10^{-6} @ 637 ug/kg	2.3×10^{-4} @ 637 ug/kg	1.7×10^{-5} @ 2,400 ug/kg	8.6×10^{-4} @ 2,400 ug/kg
1,4-dichlorobenzene	4.1×10^{-6} @ 571.4 ug/kg	2.1×10^{-4} @ 571.4 ug/kg	2.0×10^{-5} @ 2,900 ug/kg	1.0×10^{-3} @ 2,900 ug/kg
fluoranthene	5.2×10^{-6} @ 737 ug/kg	2.6×10^{-4} @ 737 ug/kg	1.9×10^{-5} @ 2,700 ug/kg	9.7×10^{-4} @ 2,700 ug/kg
naphthalene	4.7×10^{-6} @ 664.3 ug/kg	2.4×10^{-4} @ 664.3 ug/kg	1.3×10^{-5} @ 1,900 ug/kg	6.8×10^{-4} @ 1,900 ug/kg
1,2,4-trichlorobenzene	9.9×10^{-7} @ 14 ug/kg	5.1×10^{-5} @ 14 ug/kg	7.0×10^{-6} @ 980 ug/kg	3.5×10^{-4} @ 980 ug/kg
bis(2-ethylhexyl)phthalate[5]	9.8×10^{-5} @ 13,857 ug/kg	5.0×10^{-3} @ 13,857 ug/kg	6.9×10^{-4} @ 97,000 ug/kg	0.03 @ 97,000 ug/kg
Known or Suspected Carcinogens				
benzene	6.3×10^{-9} @ 18 ug/kg	4.6×10^{-7} @ 18 ug/kg	3.2×10^{-8} @ 92 ug/kg	2.4×10^{-6} @ 92 ug/kg
chloroform	1.9×10^{-9} @ 5.4 ug/kg	1.4×10^{-7} @ 5.4 ug/kg	1.1×10^{-7} @ 32 ug/kg	8.2×10^{-7} @ 32 ug/kg
methylene chloride	1.9×10^{-8} @ 53 ug/kg	5.8×10^{-7} @ 53 ug/kg	1.3×10^{-7} @ 370 ug/kg	9.5×10^{-6} @ 370 ug/kg
vinyl chloride	9.1×10^{-9} @ 26 ug/kg	6.6×10^{-7} @ 26 ug/kg	6.3×10^{-8} @ 180 ug/kg	4.6×10^{-6} @ 180 ug/kg
tetrachloroethene	6.0×10^{-10} @ 1.7 ug/kg	4.4×10^{-8} @ 1.7 ug/kg	4.2×10^{-9} @ 12 ug/kg	3.1×10^{-7} @ 12 ug/kg
PCB-1016	1.2×10^{-6} @ 3485.7 ug/kg	8.9×10^{-5} @ 3485.7 ug/kg	4.9×10^{-6} @ 14,000 ug/kg	3.6×10^{-4} @ 14,000 ug/kg
PCB-1254	8.0×10^{-9} @ 22.9 ug/kg	1.4×10^{-6} @ 22.9 ug/kg	2.8×10^{-8} @ 80 ug/kg	2.0×10^{-6} @ 80 ug/kg

Notes:
(1) Considers samples SL-001 through SL-004, SS-002, and SS-003.
(2) Calculation of the average concentration includes nondetections.
(3) The minimum soil ingestion rate is 0.1 g/day (Schaum, 1984).
(4) The maximum soil ingestion rate is 5 g/day (Schaum, 1984).
(5) Does not consider carcinogenic effects of bis(2-ethylhexyl)phthalate.
Sample calculations are provided in Appendix G.

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TABLE 8-8

DOSE ESTIMATES
DERMAL EXPOSURE TO ONSITE SURFACE SOIL AND SEDIMENT CONTAMINANTS
CALDWELL TRUCKING COMPANY SITE

Compound	Estimated Dose/Person (mg/kg-day)(1): Average Soil Concentration(2): Minimum Lifetime Soil Accumulation(3)	Average Soil Concentration(2): Maximum Lifetime Soil Accumulation(4)	Maximum Soil Concentration: Minimum Lifetime Soil Accumulation(3)	Maximum Soil Concentration: Maximum Lifetime Soil Accumulation(4)
Noncarcinogens				
toluene	1.2×10^{-7} @ 27.6 ug/kg	1.7×10^{-6} @ 27.6 ug/kg	2.5×10^{-6} @ 560 ug/kg	3.4×10^{-5} @ 560 ug/kg
ethylbenzene	6.6×10^{-7} @ 150.5 ug/kg	9.2×10^{-6} @ 150.5 ug/kg	1.8×10^{-5} @ 4,200 ug/kg	2.6×10^{-4} @ 4,200 ug/kg
xylenes	3.9×10^{-6} @ 895.3 ug/kg	5.5×10^{-5} @ 895.3 ug/kg	1.1×10^{-4} @ 25,000 ug/kg	1.5×10^{-3} @ 25,000 ug/kg
1,1,1-trichloroethane	2.0×10^{-7} @ 46.4 ug/kg	2.8×10^{-6} @ 46.4 ug/kg	5.7×10^{-6} @ 1,300 ug/kg	8.0×10^{-5} @ 1,300 ug/kg
diethyl phthalate	5.2×10^{-8} @ 11.8 ug/kg	7.2×10^{-7} @ 11.8 ug/kg	1.4×10^{-6} @ 310 ug/kg	1.9×10^{-5} @ 310 ug/kg
bis(2-ethylhexyl)phthalate(5)	7.7×10^{-8} @ 17.5 ug/kg	1.1×10^{-6} @ 17.5 ug/kg	2.2×10^{-6} @ 490 ug/kg	3.0×10^{-5} @ 490 ug/kg
naphthalene	4.9×10^{-8} @ 11.1 ug/kg	6.8×10^{-7} @ 11.1 ug/kg	1.4×10^{-6} @ 310 ug/kg	1.9×10^{-5} @ 310 ug/kg
fluoranthene	2.1×10^{-7} @ 161.4 ug/kg	9.9×10^{-6} @ 161.4 ug/kg	1.2×10^{-5} @ 2,700 ug/kg	1.7×10^{-4} @ 2,700 ug/kg
Known or Suspected Carcinogens				
tetrachloroethene	1.3×10^{-6} @ 304 ug/kg	1.9×10^{-5} @ 304 ug/kg	3.3×10^{-5} @ 7,500 ug/kg	4.6×10^{-4} @ 7,500 ug/kg
trichloroethene	9.3×10^{-7} @ 211.4 ug/kg	1.3×10^{-5} @ 211.4 ug/kg	2.5×10^{-5} @ 5,800 ug/kg	3.6×10^{-4} @ 5,800 ug/kg
chloroform	5.3×10^{-9} @ 1.2 ug/kg	7.4×10^{-8} @ 1.2 ug/kg	1.4×10^{-7} @ 33 ug/kg	2.0×10^{-6} @ 33 ug/kg
benzo(a)pyrene	1.0×10^{-7} @ 23.6 ug/kg	1.4×10^{-6} @ 23.6 ug/kg	1.4×10^{-6} @ 330 ug/kg	2.0×10^{-5} @ 330 ug/kg
4,4'-DDT	1.5×10^{-9} @ 3.4 ug/kg	2.1×10^{-8} @ 3.4 ug/kg	4.2×10^{-8} @ 95 ug/kg	5.8×10^{-7} @ 95 ug/kg
PCB-1016	3.8×10^{-6} @ 857.1 ug/kg	5.3×10^{-5} @ 857.1 ug/kg	1.0×10^{-4} @ 24,000 ug/kg	1.5×10^{-3} @ 24,000 ug/kg
PCB-1248	1.3×10^{-5} @ 2,925 ug/kg	1.8×10^{-4} @ 2925 ug/kg	3.3×10^{-4} @ 76,000 ug/kg	4.7×10^{-3} @ 76,000 ug/kg
PCB-1254	4.4×10^{-7} @ 99.6 ug/kg	6.1×10^{-6} @ 99.6 ug/kg	3.9×10^{-6} @ 890 ug/kg	5.5×10^{-5} @ 890 ug/kg
PCB-1260	3.5×10^{-7} @ 80 ug/kg	4.9×10^{-6} @ 80 ug/kg	9.3×10^{-6} @ 2,100 ug/kg	1.3×10^{-4} @ 2,100 ug/kg

Notes:
(1) Considers samples SO-001 through SO-013, SO-015 through SO-BG, SD-101 through SD-106, SD-110, SS-001, SS-005, LSS-002 and LSS-005.
(2) Calculation of the average concentration includes nondetections.
(3) The minimum estimated lifetime soil accumulation is 7,900 g (Schaum, 1984).
(4) The maximum estimated lifetime soil accumulation is 110,000 g (Schaum, 1984).
(5) Does not consider the carcinogenic effects of bis(2-ethylhexyl)phthalate.
Sample calculations are provided in Appendix G.

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TABLE 8-9

DOSE ESTIMATES
DERMAL EXPOSURE TO OFFSITE SEDIMENT CONTAMINANTS
CALDWELL TRUCKING COMPANY SITE

Compound	Estimated Dose/Person (mg/kg-day)(1): Average Sediment Concentration(2): Minimum Lifetime Soil Accumulation(3)	Average Sediment Concentration(2): Maximum Lifetime Soil Accumulation(4)	Maximum Sediment Concentration: Minimum Lifetime Soil Accumulation(3)	Maximum Sediment Concentration: Maximum Lifetime Soil Accumulation(4)
Noncarcinogens				
1,1-dichloroethane	1.2×10^{-8} @2.8 ug/kg	1.7×10^{-7} @2.8 ug/kg	4.0×10^{-8} @9 ug/kg	5.5×10^{-7} @9 ug/kg
toluene	3.4×10^{-8} @7.8 ug/kg	4.8×10^{-7} @7.8 ug/kg	1.2×10^{-7} @27 ug/kg	2.4×10^{-6} @27 ug/kg
1,1,1-trichloroethane	6.2×10^{-9} @1.4 ug/kg	8.6×10^{-8} @1.4 ug/kg	2.2×10^{-8} @5 ug/kg	3.1×10^{-7} @5 ug/kg
Known or Suspected Carcinogens				
chloroform	1.7×10^{-9} @0.4 ug/kg	2.5×10^{-8} @0.4 ug/kg	8.8×10^{-9} @2 ug/kg	1.2×10^{-7} @2 ug/kg
trichloroethene	5.7×10^{-8} @13 ug/kg	8.0×10^{-7} @13 ug/kg	1.7×10^{-7} @39 ug/kg	2.4×10^{-6} @39 ug/kg
PCB-1248	3.6×10^{-6} @820 ug/kg	5.0×10^{-5} @820 ug/kg	1.8×10^{-5} @4,100 ug/kg	2.5×10^{-4} @4,100 ug/kg
PCB-1254	1.2×10^{-5} @2,647.6 ug/kg	1.6×10^{-4} @2,647.6 ug/kg	5.4×10^{-5} @12,258 ug/kg	7.5×10^{-4} @12,258 ug/kg

Notes:

(1) Considers volatile organics and PCBs detected in samples SD-007, SD-008, SD-107, SD-108, and SD-108A. Figure 7-5 illustrates the extent of sediment contamination.
(2) Calculation of the average concentration includes nondetections.
(3) The minimum estimated lifetime soil accumulation is 7,900 g (Schaum, 1984).
(4) The maximum estimated lifetime soil accumulation is 110,000 g (Schaum, 1984).

Sample calculations are provided in Appendix G.

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TABLE 8-10

DOSE ESTIMATES
ACCIDENTAL INGESTION OF ONSITE SURFACE SOIL AND SEDIMENT CONTAMINANTS
CALDWELL TRUCKING COMPANY SITE

Compound	Estimated Dose/Person (mg/kg-day)(1): Average Soil Concentration(2): Minimum Soil Ingestion Rate(3)	Average Soil Concentration(2): Maximum Soil Injestion Rate(4)	Maximum Soil Concentration: Minimum Soil Ingestion Rate(3)	Maximum Soil Concentration: Maximum Soil Ingestion Rate(4)
Noncarcinogens				
toluene	2.0×10^{-7} @27.6 ug/kg	9.9×10^{-6} @27.6 ug/kg	4.0×10^{-6} @560 ug/kg	2.0×10^{-4} @560 ug/kg
ethylbenzene	1.1×10^{-6} @150.5 ug/kg	5.4×10^{-5} @150.5 ug/kg	3.0×10^{-5} @4,200 ug/kg	1.5×10^{-3} @4,200 ug/kg
1,1,1-trichloroethane	3.3×10^{-7} @46.4 ug/kg	1.7×10^{-5} @46.4 ug/kg	9.3×10^{-6} @1,300 ug/kg	4.7×10^{-4} @1,300 ug/kg
xylenes	6.4×10^{-6} @895.3 ug/kg	3.2×10^{-4} @845.3 ug/kg	1.8×10^{-4} @25,000 ug/kg	9.0×10^{-3} @25,000 ug//kg
diethyl phthalate	8.4×10^{-8} @11.8 ug/kg	4.2×10^{-6} @11.8 ug/kg	2.2×10^{-6} @310 ug/kg	1.1×10^{-4} @310 ug/kg
bis(2-ethylhexyl)phthalate(5)	1.2×10^{-7} @17.5 ug/kg	6.3×10^{-6} @17.5 ug/kg	3.5×10^{-6} @490 ug/kg	1.8×10^{-4} @490 ug/kg
naphthalene	7.9×10^{-8} @11.1 ug/kg	4.0×10^{-6} @11.1 ug/kg	2.2×10^{-6} @310 ug/kg	1.1×10^{-4} @310 ug/kg
fluoranthene	1.1×10^{-6} @161.4 ug/kg	5.8×10^{-5} @161.4 ug/kg	1.9×10^{-5} @2,700 ug/kg	9.7×10^{-4} @2,700 ug/kg
Known or Suspected Carcinogens				
tetrachloroethene	1.0×10^{-7} @304 ug/kg	7.8×10^{-6} @304 ug/kg	2.6×10^{-6} @7,500 ug/kg	1.9×10^{-4} @7,500 ug/kg
trichloroethene	7.3×10^{-8} @211.4 ug/kg	5.4×10^{-6} @211.4 ug/kg	2.0×10^{-6} @5,800 ug/kg	1.5×10^{-4} @5,800 ug/kg
chloroform	6.9×10^{-11} @1.2 ug/kg	3.1×10^{-8} @1.2 ug/kg	1.1×10^{-8} @33 ug/kg	8.4×10^{-7} @33 ug/kg
benzo(a)pyrene	8.2×10^{-9} @23.6 ug/kg	6.0×10^{-7} @23.6 ug/kg	1.1×10^{-7} @330 ug/kg	8.4×10^{-6} @330 ug/kg
4,4'-DDT	1.2×10^{-7} @3.4 ug/kg	8.7×10^{-8} @3.4 ug/kg	3.3×10^{-8} @95 ug/kg	2.4×10^{-6} @95 ug/kg
PCB-1016	3.0×10^{-7} @857.1 ug/kg	2.2×10^{-5} @857.1 ug/kg	8.3×10^{-6} @24,000 ug/kg	6.1×10^{-4} @24,000 ug/kg
PCB-1248	1.0×10^{-6} @2,925 ug/kg	7.5×10^{-5} @2,925 ug/kg	2.6×10^{-5} @76,000 ug/kg	1.9×10^{-3} @76,000 ug/kg
PCB-1254	3.4×10^{-8} @99.6 ug/kg	2.5×10^{-6} @99.6 ug/kg	3.1×10^{-7} @890 ug/kg	2.3×10^{-5} @890 ug/kg
PCB-1260	2.8×10^{-8} @80 ug/kg	2.0×10^{-6} @80 ug/kg	7.3×10^{-7} @2,100 ug/kg	5.4×10^{-5} @2,100 ug/kg

Notes:

(1) Considers samples SO-001 through SO-013, SO-015 through SO-BO, SD-101 through SD-106, SD-110, SS-001, SS-005, LSS-002, and LSS-005.
(2) Calculation of the average concentration includes nondetections.
(3) The minimum soil ingestion rate is 0.1 g/day (Schaum, 1984).
(4) The maximum soil ingestion rate is 5 g/day (Schaum, 1984).
(5) Does not consider carcinogenic effects of bis(2-ethylhexyl)phthalate.

Sample calculations are provided in Appendix G.

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TABLE 8-11

DOSE ESTIMATES
ACCIDENTAL INGESTION OF OFFSITE SEDIMENT CONTAMINANTS
CALDWELL TRUCKING COMPANY SITE

Compound	Estimated Dose/Person (mg/kg-day)[1] — Average Sediment Concentration[2]: Minimum Soil Ingestion Rate[3]	Average Sediment Concentration[2]: Maximum Soil Injestion Rate[4]	Maximum Sediment Concentration: Minimum Soil Ingestion Rate[3]	Maximum Sediment Concentration: Maximum Soil Ingestion Rate[4]
Noncarcinogens				
1,1-dichloroethane	2.0×10^{-8} @2.8 ug/kg	1.0×10^{-6} @2.8 ug/kg	6.4×10^{-8} @9 ug/kg	3.2×10^{-6} @9 ug/kg
toluene	5.6×10^{-8} @7.8 ug/kg	2.8×10^{-6} @7.8 ug/kg	1.9×10^{-7} @27 ug/kg	9.7×10^{-6} @27 ug/kg
1,1,1-trichloroethane	9.9×10^{-9} @1.4 ug/kg	5.0×10^{-7} @1.4 ug/kg	3.6×10^{-8} @5 ug/kg	1.8×10^{-6} @39 ug/kg
Known or Suspected Carcinogens				
chloroform	1.4×10^{-10} @0.4 ug/kg	1.0×10^{-8} @0.4 ug/kg	6.9×10^{-10} @2 ug/kg	5.1×10^{-8} @2 ug/kg
trichloroethene	4.5×10^{-9} @13 ug/kg	3.3×10^{-7} @13 ug/kg	1.3×10^{-8} @39 ug/kg	9.9×10^{-7} @39 ug/kg
PCB-1248	2.8×10^{-7} @820 ug/kg	2.1×10^{-5} @820 ug/kg	1.4×10^{-6} @4,100 ug/kg	1.0×10^{-4} @4,100 ug/kg
PCB-1254	9.1×10^{-7} @2,647.6 ug/kg	6.8×10^{-5} @2,647.6 ug/kg	4.2×10^{-6} @12,258 ug/kg	3.1×10^{-4} @12,258 ug/kg

Notes:

(1) Considers volatile organics and PCBs detected in samples SD-007, SD-008, SD-107, SD-108, and SD1-8A. Figure 7-5 illustrates the extent of sediment contamination.
(2) Calculation of the average concentration includes nondetections.
(3) The minimum soil ingestion rate is 0.1 g/day (Schaum, 1984).
(4) The maximum soil ingestion rate is 5 g/day (Schaum, 1984).

Sample calculations are provided in Appendix G.

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(e.g., maximum concentration of benzo(a)pyrene detected in onsite soil/sediment; 330 µg/kg *maximum concentration of benzo(a)pyrene detected in offsite* soil/sediment; 2,800 µg/kg). PAHs are by-products of combustion of fossil fuels and are common environmental pollutants. Dusts collected from tarred roads may contain up to 750 mg/kg of PAHs (Bjorseth, 1983). The detection of the compounds in offsite samples are not considered site-related.

Sample calculations are provided in Appendix G. Assumptions used to estimate the "worst-case" dose associated with dermal contact include

- A lifetime soil accumulation ranges from 7,900 grams to 110,000 grams (Schaum, 1984).

- One hundred percent of a compound is absorbed through the skin (McLaughlin, 1984). Ten percent of the pesticides are absorbed through the skin (McLaughlin, 1984).

- The weight of an adult is 70 kg.

- An expected lifetime is 70 years.

Assumptions used to estimate the "worst-case" dose associated with accidental ingestion of contaminated soils include

- An exposure duration ranges from 1,240 to 1,830 days (Schaum, 1984).

- 0.1 to 5 g of soil are ingested per day (Schaum, 1984).

- 100 percent of the compound is absorbed through the gastrointestinal tract.

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- The weight of a child (2 to 6 years old) likely to ingest soil is 14 kg (Schaum, 1984).

- An expected lifetime is 70 years.

8.3.4.4 Surface Water Route

Direct Contact

Local and/or distant populations may be exposed to hazardous constituents via direct contact with site impacted, or potentially impacted, surface waters.

No quantitative data are available to estimate exposures associated with infrequent, casual dermal contact or accidental ingestion during activities such as boating, fishing, or wading. These routes of exposure are of concern for receptors, particularly children, who may come into contact with hazardous constituents detected in surface water in the unnamed tributary of Deepavaal Brook. However, doses associated with swimming in Deepavaal Brook and/or the Passaic River can be quantified. Tables 8-12 and 8-13 list the doses a receptor would incur via dermal contact or accidental ingestion during swimming in Deepavaal Brook and the Passaic River.

The doses listed in Tables 8-12 and 8-13 are calculated for an adult to estimate exposure under "worst-case" conditions over a lifetime. Sample calculations are provided in Appendix G. Assumptions used to estimate these doses include

- 50 ml of water are ingested during swimming (Cabelli, 1983)

- 100 percent of the compound is absorbed through the skin during swimming (McLaughlin, 1984).

- 100 percent of the compound is absorbed through the gastrointestinal tract following ingestion.

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TABLE 8-12

DOSE ESTIMATES
DERMAL EXPOSURE DURING SWIMMING
CALDWELL TRUCKING COMPANY SITE

Compound	Estimated Dose/Person (mg/kg-day)			
	Deepavaal Brook		Passaic River	
	Dose Estimated for the Average Detected Concentration(1)	Dose Estimated for the Maximum Detected Concentration(1)	Dose Estimated for Average Flow Conditions(2)	Dose Estimated for Low Flow Conditions(2)
Noncarcinogens				
acetone	3.6×10^{-6} @ 10.5 µg/l	3.7×10^{-6} @ 11 µg/l	NC	NC
1,1-dichloroethane	ND	ND	1.7×10^{-9} @ 0.005 µg/l	4.2×10^{-8} @ 0.124 µg/l
1,1,1-trichloroethane	ND	ND	4.8×10^{-9} @ 0.014 µg/l	1.3×10^{-7} @ 0.373 µg/l
1,2,4-trichlorobenzene	ND	ND	1.3×10^{-11} @ 3.7×10^{-5} µg/l	3.4×10^{-10} @ 0.001 µg/l
phenol	ND	ND	2.1×10^{-11} @ 6.2×10^{-5} µg/l	6.8×10^{-10} @ 0.002 µg/l
benzene	1.3×10^{-8} @ 2 µg/l	2.6×10^{-8} @ 4 µg/l	NC	NC
methylene chloride	2.8×10^{-6} @ 427 µg/l	5.6×10^{-5} @ 854 µg/l	3.9×10^{-11} @ 0.006 µg/l	9.4×10^{-10} @ 0.145 µg/l
1,1-dichloroethene	ND	ND	2.6×10^{-11} @ 0.004 µg/l	5.4×10^{-10} @ 0.083 µg/l
chloroform	3.9×10^{-8} @ 6 µg/l	7.8×10^{-8} @ 12 µg/l	1.4×10^{-10} @ 0.021 µg/l	3.7×10^{-9} @ 0.564 µg/l
trichloroethene	ND	ND	4.2×10^{-10} @ 0.065 µg/l	1.1×10^{-8} @ 1.74 µg/l
tetrachloroethene	3.3×10^{-8} @ 5 µg/l	3.9×10^{-8} @ 6 µg/l	2.6×10^{-11} @ 0.004 µg/l	5.3×10^{-10} @ 0.082 µg/l
benzo(a)pyrene	ND	ND	9.7×10^{-13} @ 1.49×10^{-4} µg/l	2.6×10^{-11} @ 0.004 µg/l

Notes:

(1) *Considers samples SW-005 and SW-006*
(2) Considers estimated concentrations of contaminants in The Passaic River (Table 8-1).
ND - Not Detected
NC - Not Calculated; compound was not detected in the monitoring wells used to estimate contaminant concentrations in the Passaic River.

Sample calculations are provided in Appendix G.

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TABLE 8-13

DOSE ESTIMATES
ACCIDENTAL INGESTION DURING SWIMMING
CALDWELL TRUCKING COMPANY SITE

	Estimated Dose/Person (mg/kg-day)			
	Deepavaal Brook		Passaic River	
Compound	Dose Estimated For Average Detected Concentration(1)	Dose Estimated For Maximum Detected Concentration(1)	Dose Estimated for Average Flow Conditions	Dose Estimated for Low Flow Conditions
Noncarcinogens				
acetone	7.5×10^{-6} @ 10.5 µg/l	7.9×10^{-6} @ 11 µg/l	NC	NC
1,1-dichloroethane	ND	ND	3.6×10^{-9} @ 0.005 µg/l	8.9×10^{-9} @ 0.124 µg/l
1,1,1-trichloroethane	ND	ND	10.0×10^{-9} @ 0.014 µg/l	2.7×10^{-7} @ 0.373 µg/l
1,2,4-trichlorobenzene	ND	ND	2.6×10^{-11} @ 3.7×10^{-5} µg/l	7.1×10^{-10} @ 0.001 µg/l
phenol	ND	ND	4.4×10^{-11} @ 6.2×10^{-5} µg/l	1.4×10^{-9} @ 0.002 µg/l
Known or Suspected Carcinogens				
benzene	2.7×10^{-8} @ 2 µg/l	5.5×10^{-8} @ 4 µg/l	NC	NC
methylene chloride	5.8×10^{-6} @ 427 µg/l	1.2×10^{-5} @ 854 µg/l	8.2×10^{-11} @ 0.004 µg/l	2.0×10^{-9} @ 0.145 µg/l
1,1-dichloroethene	ND		5.5×10^{-11} @ 0.006 µg/l	1.1×10^{-9} @ 0.083 µg/l
chloroform	8.2×10^{-8} @ 6 µg/l	1.6×10^{-7} @ 12 µg/l	2.9×10^{-10} @ 0.021 µg/l	7.7×10^{-9} @ 0.564 µg/l
trichloroethene	ND	ND	8.9×10^{-10} @ 0.065 µg/l	2.4×10^{-8} @ 1.74 µg/l
tetrachloroethene	6.9×10^{-8} @ 5 µg/l	8.2×10^{-8} @ 6 µg/l	5.5×10^{-11} @ 0.004 µg/l	1.1×10^{-9} @ 0.082 µg/l
benzo(a)pyrene	ND	ND	2.0×10^{-12} @ 1.49×10^{-4} µg/l	5.5×10^{-11} @ 0.004 µg/l

Notes:

(1) Considers samples SW-005 and SW-006.
(2) Considers estimated concentrations of contaminants in the Passaic River (Table 8-1).
ND = Not Detected
NC = Not Calculated; compound was not detected in the monitoring wells used to estimate contaminant concentrations in the Passaic River.

Sample calculations are provided in Appendix G.

- Water flux through the skin is 0.5 mg/cm^2-hr (McLaughlin, 1984).

- The body weight of an adult is 70 kg.

- The body area of an adult is 18,150 cm^2 (Versar, 1986).

- An individual swims 2.6 hours per day, 7 days a year, for 70 years (Versar, 1986).

Ingestion of Fish

Sampling and analysis of fish tissue from aquatic biota in Deepavaal Brook or the Passaic River were not conducted during the RI. To estimate the "worst-case" dose a local or distant receptor may receive via this route, the concentration of contaminants in fish tissue were estimated by multiplying the bioconcentration factor (BF) by the observed or calculated surface water concentration (ICF, Inc., 1985). Assuming ingestion of 6.5 grams of fish per day, doses associated with ingestion of fish from the Deepavaal Brook and Passaic River were calculated. The results are listed in Tables 8-14 and 8-15. Sample calculations and assumptions are provided in Appendix G.

Long-Term Ingestion

Downstream communities use the Passaic River as a source of potable water. Long-term ingestion of contaminated river water is considered a minor route of exposure for distant populations.

Methylene chloride, a common laboratory contaminant, was the only HSL organic compound detected in the Passaic River, downstream of Deepavaal Brook. Exposures to downstream receptors will be minimal because of contaminant attenuation by dilution and volatilization.

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TABLE 8-14

DOSE ESTIMATES
INGESTION OF FISH - DEEPAVAAL BROOK
CALDWELL TRUCKING COMPANY SITE

Compound	Bioconcentration Factor (BCF)	Estimated Fish Concentration (µg/kg) Average Concentration (1)	Estimated Fish Concentration (µg/kg) Maximum Concentration (2)	Estimated Dose/Person (mg/kg-day) Average Concentration (1)	Estimated Dose/Person (mg/kg-day) Maximum Concentration (2)
Noncarcinogens					
acetone	0.39	4.0	4.29	3.8×10^{-7}	4.0×10^{-7}
Known or Suspected Carcinogens					
benzene	24.5	49	98	4.6×10^{-6}	9.1×10^{-6}
methylene chloride	5.24	2,239	4,474	2.0×10^{-4}	4.1×10^{-4}
chloroform	18.5	120	222	1.0×10^{-5}	2.1×10^{-5}
tetrachloroethene	55.7	278.5	334	2.6×10^{-5}	3.1×10^{-5}

Notes:

(1) Estimated fish concentrations were calculated from the average concentration in surface water samples SW-005 and SW-006 and the Bioconcentration Factor (BCF).(ICF, Inc., 1985).

(2) Estimated fish concentration were calculated from the maximum concentration in surface water samples SW-005 or SW-006 and the BCF.

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TABLE 8-15

DOSE ESTIMATES
INGESTION OF FISH - PASSAIC RIVER
CALDWELL TRUCKING COMPANY SITE

Compound	Bioconcentration Factor (BCF)	Estimated Fish Concentration (µg/kg) (1)		Estimated Dose/Person (mg/kg-day)	
		Average Concentration (2)	Maximum Concentration (3)	Average Concentration	Maximum Concentration
Noncarcinogens					
1,1-dichloroethane	13.5	0.06	0.96	6.3×10^{-9}	1.5×10^{-7}
1,1,1-trichloroethane	26.2	3.66	9.8	3.4×10^{-7}	9.0×10^{-7}
1,2,4-trichlorobenzene	1,017	0.038	1.0	3.4×10^{-9}	9.4×10^{-8}
phenol	7.58	4.7×10^{-4}	0.015	4.3×10^{-11}	1.4×10^{-9}
Known or Suspected Carcinogens					
methylene chloride	5.24	0.03	0.75	2.9×10^{-9}	7.0×10^{-8}
1,1-dichloroethene	7.8	0.03	0.64	2.9×10^{-9}	6.0×10^{-8}
chloroform	18.5	0.38	10.4	3.6×10^{-8}	9.7×10^{-7}
trichloroethene	32.3	2.1	56.2	1.9×10^{-7}	5.2×10^{-6}
tetrachloroethene	55.7	0.22	4.57	2.1×10^{-8}	4.2×10^{-7}
benzo(a)pyrene	22,929	3.41	91.7	3.1×10^{-7}	8.5×10^{-6}

Notes:

(1) Calculated using the estimated concentration in the Passaic River and the bioconcentration factor (BCF).
(2) Calculation using the average concentration listed in Table 8-1.
(3) Calculated using the maximum concentration listed in Table 8-1.

Sample calculations are provided in Appendix G.

To estimate "worst-case" exposures via ingestion of contaminated river water, the estimated river concentrations presented in Table 8-1 were used to calculate a dose for a distant receptor. Table 8-16 lists these doses. These estimates assume a 70 kg man ingests 2 liters of water per day. Sample calculations are provided in Appendix G.

8.4 Risk Characterization

The hazard and exposure assessments presented in Sections 8.2 and 8.3 provided a characterization of the actual or potential exposures and hazards posed by the contaminants present at the site. In the following section, the results of the hazard and exposure assessments are combined to determine the actual and potential public health risks resulting from exposure to site contaminants.

Risk assessments can be either qualitative, quantitative, or both. Both forms are considered in this assessment. Qualitative and quantitative risk estimates give an indication of the magnitude of the potential for adverse health or environmental impacts resulting from exposure to toxic substances.

8.4.1 Noncarcinogenic Risk

A qualitative risk assessment is usually performed for noncarcinogens. A qualitative assessment is conducted by

- A comparison of observed or estimated environmental concentrations to relevant standards, criteria, or guidelines presented in the dose-response evaluation (Table E-1, Appendix E).

- A comparison of estimated doses calculated in Section 8.3 to Acceptable Daily Intakes (ADIs). A summary of the estimated doses for non-carcinogens and the corresponding ADIs are presented in Table 8-17.

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TABLE 8-16

DOSES ESTIMATES
LONG-TERM INGESTION OF SURFACE WATER - PASSAIC RIVER
CALDWELL TRUCKING COMPANY SITE

Compound	Estimated Dose/Person (mg/kg-day) Dose Estimated For Average Flow Conditions (1)	Dose Estimated For Low Flow Conditions (1)
Noncarcinogens		
1,1-dichloroethane	1.4×10^{-7} @ 0.005 ug/l	3.5×10^{-6} @ 0.124 ug/l
1,1,1-trichloroethane	3.9×10^{-7} @ 0.014 ug/l	1.0×10^{-5} @ 0.373 ug/l
1,2,4-trichlorobenzene	1.0×10^{-9} @ 3.71×10^{-5} ug/l	2.8×10^{-8} @ 0.001 ug/l
phenol	1.8×10^{-9} @ 6.19×10^{-5} ug/l	5.6×10^{-8} @ 0.002 ug/l
Known or Suspected Carcinogens		
methylene chloride	1.7×10^{-7} @ 0.006 ug/l	4.1×10^{-6} @ 0.145 ug/l
1,1-dichloroethene	1.1×10^{-7} @ 0.004 ug/l	2.3×10^{-6} @ 0.83 ug/l
chloroform	5.9×10^{-7} @ 0.021 ug/l	1.6×10^{-5} @ 0.564 ug/l
trichloroethene	1.8×10^{-6} @ 0.065 ug/l	4.9×10^{-5} @ 1.740 ug/l
tetrachloroethene	1.1×10^{-7} @ 0.004 ug/l	2.3×10^{-6} @ 0.082 ug/l
benzo(a)pyrene	4.2×10^{-9} @ 1.9×10^{-4} ug/l	1.1×10^{-7} @ 0.004 ug/l

Notes:

(1) Calculation of doses are based on estimated concentrations of hazardous constituents in the Passaic River (Table 8-1). Assumptions and sample calculations are provided in Appendix G.

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A discussion of noncarcinogenic risks associated with exposure pathways of concern follows.

8.4.1.1 Groundwater Route - Contaminant Plume

To provide a "worst-case" estimation of public health risks associated with ingestion of contaminated groundwater in the contaminant plume, the results of all of the residential well samples are used to characterize potential health risks via each potential exposure pathway. It must be emphasized that not all receptors are exposed to hazardous constituents in drinking water. However, receptors may be exposed at some future time as a result of alterations in the hydraulic gradient due to local pumping influences and/or transverse dispersion of the contaminant plume. Also, the possibility that there are receptors who are located within the plume who use groundwater as a potable water supply source has not be eliminated.

Ingestion

A measure of acute and subchronic toxic effects associated with ingestion of contaminated groundwater in the residential well samples can be estimated by comparing the observed concentrations with the EPA 1-day and 10-day Suggested-No-Adverse-Response-Levels (SNARLs) (Table E-2).

None of the contaminants (trichloroethene) detected in RW-003 and RW-004 exceed 1-day or 10-day SNARLs. However, short-term ingestion of groundwater at the observed concentrations in RW-001 and RW-002 is of concern.

Contaminants detected in RW-001 and/or RW-002 that exceed 1-day or 10-day SNARLs include methylene chloride (RW-001; 10-day SNARLs), trans-1,2-dichloroethene, (RW-001 and RW-002; 10-day SNARLs); trichloroethene (RW-001 and RW-002; 1-day and 10-day SNARLs), and tetrachloroethene (RW-001 and RW-002; 10-day SNARLs). Based on this comparison, acute and subchronic health effects associated with short-term ingestion of the most contaminated groundwater are possible. Of particular concern are residents who use groundwater

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for outdoor purposes. Occasional ingestion, particularly with children who may ingest drinking water from a garden hose or outside tap, may be associated with adverse health implications.

Chronic toxic effects (where a threshold limit may exist) may result from long-term repeated ingestion of groundwater in the most contaminated residential wells (RW-001 and RW-002). The most relevant criteria used to evaluate the potential for health impacts are the long-term SNARLs listed in Table E-2. In the absence of SNARLs for individual contaminants, estimated doses (Table 8-17) can be compared to ADIs for chronic exposure.

Contaminants detected in residential well samples (RW-001 and RW-002) that exceed long-term SNARLs, include methylene chloride, 1,1-dichloroethene, 1,1,1-trichloroethene, and tetrachloroethene. None of the estimated doses exceed ADIs.

Although it is believed that these receptors do not use groundwater for drinking purposes, long-term ingestion at the observed concentrations is likely to be associated with adverse chronic health impacts. Receptors in the vicinity of the site who uses groundwater as a source of drinking water may be at risk at some future time if contaminants migrate to potable wells used for drinking purposes.

Inorganic compounds detected in residential well samples that exceed National Interim Primary Drinking Water Standard - Maximum Contaminant Levels include cadmium detected in RW-004 at a concentration of 15 µg/l. Nickel exceeded the AWQC of 15.4 µg/l for ingestion of drinking water in residential well samples RW-001 through RW-005, and RW-007. Based on these comparisons, there may be a potential for chronic toxic effects associated with the presence of inorganic compounds in drinking water. However, these compounds are not considered to be site related.

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Inhalation

Domestic uses of contaminated groundwater can significantly add to the dose a receptor receives. Although there are no standards or criteria to evaluate the potential for health impacts associated with domestic use, estimated exposure levels, calculated in Section 9.4, can be compared to ADIs for chronic exposure.

Table 8-17 compared the estimated exposure levels during showering with ADIs. None of the contaminants exceed these criteria. Based on this comparison, chronic toxic effects associated with inhalation during showering are not a consideration.

To assess the total potential noncarcinogenic risk posed by multiple subthreshold exposures via inhalation, a hazard index can be calculated (USEPA, 1985e). The hazard index assumes that the magnitude of the adverse effect is proportional to the sum of the ratios of the subthreshold exposures to acceptable exposures. This can be expressed as follows:

$$\text{Hazard Index} = E_1/AL_1 + E_2/AL_2 + ... + E_i/AL_i$$

where E_i = Exposure level (or intake) for the i^{th} toxicant
AL_i = Acceptable level (or intake) for the i^{th} toxicant

When a hazard index is greater than 1, exposures to subthreshold concentrations are of concern. The hazard index is not a mathematical prediction of incidence or severity of effects; it is simply a numerical indicator of the transition from acceptable to unacceptable exposure levels.

Hazard indices calculated for inhalation in RW-001 and RW-002 are 0.23 and 0.35, respectively. These hazard indices indicate exposure to multiple subthreshold concentrations are not of concern. However, since most of the compounds detected in the residential well samples do not have ADIs, the potential for chronic toxic effects associated with inhalation cannot be completely eliminated.

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Nonpotable Uses

There are no standards or criteria to evaluate the potential for health impacts associated with exposure to contaminated groundwater during activities such as car washing, lawn watering, or industrial use. As discussed in the preceding section, acute short-term ingestion is an exposure pathway of concern, particularly for receptors who use contaminated groundwater for outdoor use. Depending upon the frequency and duration of exposure, frequent dermal contact or inhalation of volatilized contaminants associated with the use of contaminated groundwater during car washing, lawn watering, etc. could potentially be associated with adverse chronic health impacts.

8.4.1.2 Groundwater Route - Municipal Well No. 7

Presently, Municipal Well No. 7 is not used as a source of potable water. Consequently, there are no receptors exposed via this route. The detection of HSL organic constituents in this well may or may not be site-related. However, to completely characterize the potential for adverse health impacts from possible site-associated contaminants, Municipal Well No. 7 is considered to estimate a "worst-case" exposure scenario associated with groundwater use.

Ingestion

The most applicable criteria used to evaluate the potential for acute or subchronic health impacts from the ingestion of contaminated groundwater at the observed concentrations in Municipal Well No. 7 are 1-day and 10-day SNARLs (Table E-1). Tetrachloroethene (maximum concentration; 310 µg/l) and trichloroethene (maximum concentration; 530 µg/l) exceed levels associated with subchronic health impacts. Based on this comparison, there is a potential for adverse health effects following short-term exposure, if the contaminants are ingested at the observed concentrations.

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Chronic toxic effects associated with long-term ingestion at the observed concentrations are also possible. Contaminants detected in Municipal Well No. 7 that exceed long-term SNARLs (Table E-1) include tetrachloroethene, trichloroethene, and carbon tetrachloride. None of the estimated doses exceed ADIs.

Inhalation

There are no standards or criteria to evaluate the potential for health impacts associated with inhalation during showering. However, estimated exposure levels can be compared to ADIs.

Table 8-17 compared the estimated exposure levels associated with inhalation of contaminated groundwater during showering to ADIs. None of the estimated doses exceed ADIs. Consequently, adverse health impacts are not expected.

Hazard indices calculated for inhalation of the average and maximum concentration of hazardous constituents in Municipal Well No. 7 are 0.04 and 0.05, respectively. These hazard indices indicate exposure to multiple subthreshold concentrations are unlikely to be associated with adverse chronic health impacts.

8.4.1.3 Wastes

Direct Contact

There are no standards or criteria to evaluate the potential for acute or chronic toxic effects associated with dermal exposure or accidental ingestion of wastes in the existing lagoon. However, estimated exposure levels calculated in Section 8.4 can be compared to ADIs. Table 8-17 provided this comparison. All estimated exposure levels are below ADIs. Based on this comparison, direct contact with wastes in the existing lagoon is unlikely to be associated with adverse chronic health impacts.

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Hazard indices calculated for direct contact with wastes are shown below.

Direct Contact	8.2×10^{-4} - 0.049
Accidental Ingestion	1.3×10^{-3} - 0.28

The hazard indices indicate that exposure to multiple subthreshold concentrations are not of concern. However, the potential for localized skin effects and/or adverse health impacts from exposure to high concentrations of inorganic constituents (e.g., lead) in wastes cannot be completely eliminated.

8.4.1.4 Soil Route

Direct Contact

To evaluate the potential for chronic toxic effects associated with dermal exposure or accidental ingestion of contaminated surface soils, estimated exposure levels calculated in Section 8.3 can be compared to ADIs. Table 8-17 provided this comparison. All estimated exposure levels are below ADIs. Based on this comparison, exposure via direct contact to surface soils or sediments are unlikely to be associated with systemic health effects.

Hazard indices calculated for dermal contact and accidental ingestion to onsite and offsite soils and sediments are shown below.

	Onsite Soils	Offsite Soils
Dermal Contact	4.3×10^{-5}-0.03	1.9×10^{-7}-1.1×10^{-5}
Accidental Ingestion	1.9×10^{-4}-0.046	3.2×10^{-7}-5.3×10^{-5}

The hazard indices also indicate that exposure to multiple sub-threshold concentrations via direct contact are not of concern.

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The potential for localized effects or adverse skin reactions, are not considered in this evaluation. The presence of dermally active compounds (i.e., PCBs) in both onsite and offsite surface soils and sediments suggest that the potential for adverse affects associated with dermal exposure cannot be completely discounted. In addition, the high concentrations of lead detected in onsite surface soils are of concern. Accidental ingestion of onsite soils may significantly add to the lead body burden. Children represent a sensitive subgroup of the population with regard to lead exposure. Of major concern are the reported subtle effects of lead on behavior in children. Children entering the site, particularly those who enter the site on a daily basis, may be at risk.

8.4.1.5 Surface Water Route

Direct Contact

There are no standards or criteria to evaluate the potential for acute or chronic toxic effects associated with direct contact or accidental ingestion of surface water contaminants following intermittent or long-term exposure.

Infrequent dermal contact or accidental ingestion of surface waters in Deepavaal Brook and/or the Passaic River are unlikely to be associated with adverse health impacts. Although there are no standards or criteria to evaluate the potential for acute impacts, the low levels of volatile organic compounds observed and/or predicted in these surface water bodies are not considered an acute hazard in circumstances similar to those observed at the site.

To evaluate the potential for adverse health impacts following chronic exposure, such as would occur during swimming, estimated doses calculated in Section 8.3 can be compared to ADIs. Table 8-17 provided this comparison.

None of the doses a receptor would likely incur via dermal absorption or accidental ingestion as a result of swimming in Deepavaal Brook or the Passaic River exceed the ADIs. Consequently, the potential for chronic toxic effects associated with

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long-term dermal contact or accidental ingestion during swimming in either of these surface water bodies is unlikely.

Hazard indices calculated for these modes of exposure are as follows.

	Deepavaal Brook	Passaic River
Dermal Contact During Swimming	$1.2x10^{-6}$–$1.3x10^{-6}$	$2.4x10^{-8}$–$6.1x10^{-7}$
Accidental Ingestion During Swimming	$2.6x10^{-6}$–$2.7x10^{-6}$	$5.0x10^{-8}$–$1.3x10^{-6}$

These indices indicate that exposure to multiple sub-threshold concentrations are unlikely to pose a potential for adverse chronic health effects.

Exposure via dermal contact with, or accidental ingestion of surface waters adjacent to the site, may be of concern. Relatively high concentrations of HSL organic compounds were detected in surface water in the unnamed tributary of Deepavaal Brook directly adjacent to the site. Frequent exposure, particularly for children who may readily come into contact with these compounds, could potentially be associated with adverse chronic health implications.

The presence of several inorganic contaminants detected in surface water samples is also of concern. Inorganic contaminants in the Passaic River, Deepavaal Brook, and/or the unnamed tributary of Deepavaal Brook which exceed AWQC for the protection of human health include cadmium, lead, nickel, and silver. Surface water samples collected during the RI were unfiltered prior to preservation in acid for metal analysis and reflect the total metal concentration (in water and suspended sediments in the sample) rather than the dissolved metal concentration. Consequently, risks may be overestimated.

Ingestion of Fish

Ingestion of fish is considered to pose a very low potential for chronic toxic effects (where a threshold limit may exist). None of the compounds detected or estimated

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in the Passaic River or Deepavaal Brook exceed the AWQC for the protection of human health from the ingestion of aquatic organisms. In addition, estimated doses associated with consumption of fish from both of these surface water bodies are below ADIs for chronic exposure. This comparison is provided in Table 8-17. Consequently, long-term ingestion of fish from the Passaic River and/or Deepavaal Brook is unlikely to be associated with adverse chronic health impacts.

Hazard indices for ingestion of fish are as follows.

	Deepavaal Brook	Passaic River
Ingestion of Fish	1.3×10^{-7}-1.4×10^{-7}	8.1×10^{-7}-6.6×10^{-6}

These indices indicate that exposure to multiple sub-threshold concentrations are unlikely to pose a potential for adverse chronic health impacts.

Long-Term Ingestion

Long-term ingestion of surface water in the Passaic River is considered a minor potential route of exposure to distant receptors. Estimated river concentrations due to groundwater recharge from the contaminant plume were calculated in Section 8.3 to provide a "worst-case" exposure scenario.

A comparison of the estimated concentrations to relevant standards, criteria and guidelines presented in Table E-2, Appendix E, indicates chronic effects from long-term ingestion is not considered an exposure pathway of consequence. All of the estimated concentrations are below SNARLs and AWQC. Estimated doses calculated in Section 8.4.4 are also below ADIs. A comparison of the estimated doses and ADIs is provided in Table 8-17.

The hazard index calculated for long-term ingestion of surface water ranges from 2.0×10^{-6} to 5.0×10^{-6}. The index indicates chronic effects from exposure to multiple sub-threshold concentrations are not of concern.

TABLE 8-17

SUMMARY OF ESTIMATED DOSES - NONCARCINOGENS
CALDWELL TRUCKING COMPANY SITE

Compound	Groundwater Route-Contaminant Plume (mg/kg-day)								Acceptable Daily Intake (mg/kg-day)
	Ingestion				Inhalation				
	RW-001	RW-002	RW-003	RW-004	RW-001	RW-002	RW-003	RW-004	
acetone	ND	0.01	ND	ND	ND	0.0179	ND	ND	2.86
1,1-dichloroethane	0.004	0.004	ND	ND	0.007	0.006	ND	ND	0.12
1,1,1-trichloroethane	0.05	0.10	ND	ND	0.09	0.156	ND	ND	0.54

Compound	Groundwater Route-Municipal Well No. 7 (mg/kg-day)		Acceptable Daily Intake (mg/kg-day)
	Ingestion	Inhalation	
1,1-dichloroethane	$1.7 \times 10^{-4} - 1.7 \times 10^{-4}$	$2.7 \times 10^{-4} - 2.7 \times 10^{-4}$	0.12
1,1,1-trichloroethane	0.015 - 0.018	0.023 - 0.028	0.54
toluene	$1.4 \times 10^{-5} - 2.9 \times 10^{-5}$	$2.2 \times 10^{-5} - 4.5 \times 10^{-5}$	0.43

Compound	Wastes (mg/kg-day)		Acceptable Daily Intake (mg/kg-day)
	Dermal Contact	Accidental Inhalation	
acetone	$2.1 \times 10^{-7} - 2.1 \times 10^{-5}$	$3.4 \times 10^{-7} - 1.2 \times 10^{-4}$	2.86
chlorobenzene	$9.7 \times 10^{-7} - 4.8 \times 10^{-5}$	$2.2 \times 10^{-6} - 2.8 \times 10^{-4}$	0.014
1,1-dichloroethane	$5.8 \times 10^{-8} - 5.6 \times 10^{-6}$	$1.3 \times 10^{-7} - 3.3 \times 10^{-5}$	0.12
ethylbenzene	$5.8 \times 10^{-8} - 5.6 \times 10^{-6}$	$1.3 \times 10^{-7} - 3.3 \times 10^{-5}$	0.13
xylenes	$6.8 \times 10^{-8} - 5.6 \times 10^{-6}$	$1.5 \times 10^{-7} - 3.3 \times 10^{-5}$	2.28
1,2-dichlorobenzene	$1.7 \times 10^{-6} - 1.2 \times 10^{-4}$	$3.8 \times 10^{-6} - 6.8 \times 10^{-4}$	0.09
1,3-dichlorobenzene	$2.8 \times 10^{-6} - 1.5 \times 10^{-4}$	$5.4 \times 10^{-6} - 8.6 \times 10^{-4}$	0.09
1,4-dichlorobenzene	$2.5 \times 10^{-6} - 1.8 \times 10^{-4}$	$5.7 \times 10^{-6} - 1.0 \times 10^{-5}$	0.12
fluoranthene	$3.2 \times 10^{-6} - 1.7 \times 10^{-4}$	$4.7 \times 10^{-6} - 9.7 \times 10^{-4}$	6.0×10^{-3}
naphthalene	$2.9 \times 10^{-6} - 1.2 \times 10^{-4}$	$1.4 \times 10^{-6} - 6.8 \times 10^{-4}$	0.26
1,2,4-trichlorobenzene	$6.2 \times 10^{-8} - 6.0 \times 10^{-5}$	$1.4 \times 10^{-6} - 3.5 \times 10^{-4}$	0.026
bis(2-ethylhexyl)phthalate	$6.1 \times 10^{-5} - 5.9 \times 10^{-3}$	$1.4 \times 10^{-4} - 0.03$	0.6

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TABLE 8-17
SUMMARY OF ESTIMATED DOSES
CALDWELL TRUCKING COMPANY SITE
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Compound	Soil Route (mg/kg-day): Onsite Soil: Dermal Contact	Onsite Soil: Accidental Ingestion	Offsite Soil: Dermal Contact	Offsite Soil: Accidental Ingestion	Acceptable Daily Intake (mg/kg-day)
toluene	$1.2x10^{-7}$-$3.4x10^{-5}$	$2.0x10^{-7}$-$2.0x10^{-4}$	$3.4x10^{-8}$-$2.4x10^{-6}$	$5.6x10^{-8}$-$9.7x10^{-6}$	0.43
1,1,1-trichloroethane	$2.0x10^{-7}$-$8.0x10^{-5}$	$3.3x10^{-7}$-$4.7x10^{-4}$	$6.2x10^{-9}$-$3.1x10^{-7}$	$9.9x10^{-9}$-$1.8x10^{-6}$	0.54
1,1-dichloroethane	ND	ND	$1.2x10^{-8}$-$5.5x10^{-7}$	$2.0x10^{-8}$-$3.2x10^{-6}$	0.12
ethylbenzene	$6.6x10^{-7}$-$2.6x10^{-4}$	$1.1x10^{-6}$-$1.5x10^{-3}$	ND	ND	0.13
xylenes	$3.9x10^{-6}$-$1.5x10^{-3}$	$6.4x10^{-6}$-$9.0x10^{-3}$	ND	ND	2.28
diethyl phthalate	$5.2x10^{-8}$-$1.9x10^{-5}$	$8.4x10^{-8}$-$1.1x10^{-4}$	ND	ND	12.6
bis(2-ethylhexyl) phthalate	$7.7x10^{-8}$-$3.0x10^{-5}$	$1.2x10^{-7}$-$1.8x10^{-4}$	ND	ND	0.6
naphthalene	$4.9x10^{-8}$-$1.9x10^{-5}$	$7.9x10^{-8}$-$1.1x10^{-4}$	ND	ND	0.26
fluoranthene	$2.1x10^{-7}$-$1.5x10^{-4}$	$1.1x10^{-6}$-$9.7x10^{-7}$	ND	ND	$6.0x10^{-3}$

Compound	Surface Water Route (mg/kg-day): Deepavaal Brook: Dermal Exposure During Swimming	Accidental Ingestion During Swimming	Ingestion of Fish	Acceptable Daily Intake (mg/kg-day)
acetone	$3.6x10^{-7}$-$3.7x10^{-6}$	$7.5x10^{-6}$-$7.9x10^{-6}$	$3.8x10^{-7}$-$4.0x10^{-7}$	2.86

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Compound	Surface Water Route (mg/kg-day): Passaic River: Dermal Exposure During Swimming	Accidental Ingestion During Swimming	Ingestion of Fish	Long-Term Ingestion	Acceptable Daily Intake (mg/kg-day)
1,1-dichloroethane	$1.7x10^{-9}$-$4.2x10^{-8}$	$3.6x10^{-9}$-$8.9x10^{-9}$	$6.3x10^{-9}$-$1.5x10^{-7}$	$1.4x10^{-7}$-$3.5x10^{-6}$	0.12
1,1,1-trichloroethane	$4.8x10^{-9}$-$1.3x10^{-7}$	$10.0x10^{-9}$-$2.7x10^{-7}$	$3.4x10^{-7}$-$9.0x10^{-7}$	$3.9x10^{-7}$-$1.0x10^{-5}$	0.54
1,2,4-trichlorobenzene	$1.3x10^{-11}$-$3.4x10^{-10}$	$2.6x10^{-11}$-$7.1x10^{-10}$	$3.4x10^{-9}$-$9.4x10^{-8}$	$1.0x10^{-9}$-$2.8x10^{-8}$	0.026
phenol	$2.1x10^{-11}$-$6.8x10^{-10}$	$4.4x10^{-11}$-$1.4x10^{-9}$	$4.3x10^{-11}$-$1.4x10^{-9}$	$1.8x10^{-9}$-$5.6x10^{-8}$	0.1

Note: ND - Not Detected

The detection of methylene chloride in the Passaic River (SW-003) at a concentration of 200 µg/l is expected to pose minimal hazards to downstream receptors. Dilution and volatilization will significantly reduce the concentration at downstream locations.

8.4.2 Carcinogenic Risk

Carcinogenic risk can be calculated by using the following equation:

Risk = (q) (dose)

where:

q = Unit Cancer Risk Slope Factor $(mg/kg\text{-}day)^{-1}$

dose = Daily dose of a compound averaged over an individual's lifetime and body weight

Estimation of lifetime cancer risk is limited to those compounds for which an evaluation has been conducted by the EPA Carcinogenic Assessment Group (CAG). The Unit Cancer Risk Slope Factors developed the EPA CAG are presented in Table E-1, Appendix E. The estimated lifetime doses associated with the primary exposure pathways of concern were presented in Section 8.3.4.

Using the preceding equation, the lifetime cancer risks associated with exposure to known or suspected individual carcinogens were calculated. The results are listed in Table 8-18. The risks presented represent the upper-bound "worst-case" range of potential carcinogenic risks following lifetime exposure to a site associated compound.

To assess the total risk posed by the presence of more than one known or suspected carcinogen, risks estimates for individual compounds are added. Additive risks are also presented in Table 8-17.

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TABLE 8-18

ESTIMATED LIFETIME CANCER RISKS
CALDWELL TRUCKING COMPANY SITE

Groundwater Route - Contaminant Plume
Estimated Lifetime Cancer Risk/Person

Compound	Ingestion				Inhalation			
	RW-001	RW-002	RW-003	RW-004	RW-001	RW-002	RW-003	RW-004
benzene	$1.8x10^{-5}$	$3.3x10^{-5}$	ND	ND	$2.8x10^{-5}$	$5.2x10^{-5}$	ND	ND
methylene chloride	$2.7x10^{-3}$	$3.6x10^{-5}$	ND	ND	$7.8x10^{-3}$	$1.1x10^{-4}$	ND	ND
1,1-dichloroethene	$1.7x10^{-3}$	$1.7x10^{-3}$	ND	ND	$2.6x10^{-3}$	$2.6x10^{-3}$	ND	ND
chloroform	$6.3x10^{-3}$	$7.2x10^{-3}$	ND	ND	$9.9x10^{-3}$	$1.1x10^{-2}$	ND	ND
trichloroethene	$2.9x10^{-3}$	$4.8x10^{-3}$	$2.5x10^{-6}$	$5.5x10^{-6}$	$4.6x10^{-3}$	$7.5x10^{-3}$	$4.0x10^{-6}$	$8.6x10^{-6}$
tetrachloroethene	$6.5x10^{-4}$	$6.5x10^{-4}$	ND	ND	$1.0x10^{-3}$	$1.0x10^{-3}$	ND	ND
TOTAL RISK	$1.4x10^{-2}$	$1.4x10^{-2}$	$2.5x10^{-6}$	$5.5x10^{-6}$	$2.6x10^{-2}$	$2.2x10^{-2}$	$4.0x10^{-6}$	$8.6x10^{-6}$

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TABLE 8-18
ESTIMATED LIFETIME CANCER RISKS
CALDWELL TRUCKING COMPANY SITE
PAGE TWO

Compound	Groundwater Route - Municipal Well No. 7 Estimated Lifetime Cancer Risk/Person Ingestion	Inhalation
carbon tetrachloride	1.3×10^{-4} - 1.6×10^{-4}	2.0×10^{-4} - 2.6×10^{-4}
1,1-dichloroethene	2.0×10^{-4} - 2.3×10^{-4}	3.1×10^{-4} - 3.6×10^{-4}
trichloroethene	1.5×10^{-4} - 1.8×10^{-4}	2.4×10^{-4} - 2.8×10^{-4}
tetrachloroethene	4.5×10^{-4} - 5.3×10^{-4}	7.1×10^{-4} - 8.3×10^{-4}
TOTAL RISK	9.3×10^{-4} - 1.1×10^{-3}	1.5×10^{-3} - 1.7×10^{-3}

TABLE 8-18
ESTIMATED LIFETIME CANCER RISKS
CALDWELL TRUCKING COMPANY SITE
PAGE THREE

Compound	Wastes Estimated Lifetime Cancer Risk/Person	
	Dermal Contact	Accidental Ingestion
benzene	2.3×10^{-9} - 1.6×10^{-7}	1.8×10^{-10} - 6.8×10^{-8}
chloroform	1.7×10^{-9} - 1.4×10^{-7}	1.3×10^{-10} - 5.7×10^{-8}
methylene chloride	1.7×10^{-9} - 1.7×10^{-7}	1.4×10^{-10} - 7.1×10^{-8}
vinyl chloride	2.0×10^{-9} - 1.9×10^{-7}	1.6×10^{-10} - 8.1×10^{-8}
tetrachloroethene	4.5×10^{-10} - 4.4×10^{-8}	3.6×10^{-11} - 1.8×10^{-8}
PCB-1016	6.7×10^{-5} - 3.7×10^{-3}	5.3×10^{-6} - 1.6×10^{-3}
PCB-1254	5.3×10^{-7} - 2.1×10^{-5}	3.5×10^{-8} - 8.9×10^{-6}
TOTAL RISK	6.8×10^{-5} - 3.7×10^{-3}	5.3×10^{-6} - 1.6×10^{-3}

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TABLE 8-18
ESTIMATED LIFETIME CANCER RISKS
CALDWELL TRUCKING COMPANY SITE
PAGE FOUR

	Soil Route: Estimated Lifetime Cancer Risk/Person			
	Onsite Soil		Offsite Soil	
Compound	Dermal Contact	Accidental Ingestion	Dermal Contact	Accidental Ingestion
chloroform	3.7×10^{-10} - 1.4×10^{-7}	4.8×10^{-12} - 5.9×10^{-8}	1.2×10^{-10} - 8.6×10^{-9}	8.7×10^{-12} - 3.6×10^{-9}
tetrachloroethene	8.0×10^{-8} - 2.7×10^{-5}	6.3×10^{-9} - 1.1×10^{-5}	ND	ND
trichloroethene	1.1×10^{-8} - 4.3×10^{-6}	8.8×10^{-10} - 1.8×10^{-6}	6.9×10^{-10} - 2.9×10^{-8}	5.4×10^{-11} - 1.2×10^{-8}
benzo(a)pyrene	1.2×10^{-6} - 2.3×10^{-4}	9.4×10^{-8} - 9.7×10^{-5}	NC	ND
4'4'-DDT	5.1×10^{-10} - 2.0×10^{-7}	4.1×10^{-10} - 8.3×10^{-7}	ND	ND
PCB-1016	1.6×10^{-5} - 6.4×10^{-3}	1.3×10^{-6} - 2.7×10^{-3}	ND	ND
PCB-1248	5.6×10^{-5} - 2.0×10^{-2}	4.4×10^{-6} - 8.4×10^{-3}	1.6×10^{-5} - 1.0×10^{-3}	1.2×10^{-6} - 4.5×10^{-4}
PCB-1254	1.9×10^{-6} - 2.4×10^{-4}	1.5×10^{-7} - 9.9×10^{-5}	5.1×10^{-5} - 3.0×10^{-3}	3.9×10^{-6} - 1.4×10^{-3}
PCB-1260	1.5×10^{-6} - 5.6×10^{-4}	1.2×10^{-7} - 2.3×10^{-4}	ND	ND
TOTAL RISK	7.7×10^{-5} - 2.7×10^{-2}	6.1×10^{-6} - 1.1×10^{-2}	6.7×10^{-5} - 4.0×10^{-3}	5.1×10^{-6} 1.8×10^{-3}

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TABLE 8-18
ESTIMATED LIFETIME CANCER RISKS
CALDWELL TRUCKING COMPANY SITE
PAGE FIVE

Compound	Surface Water Route – Estimated Lifetime Cancer Risk/Person – Deepavaal Brook: Dermal Exposure during Swimming	Accidental Ingestion during Swimming	Ingestion of Fish
benzene	$3.8x10^{-10}$ - $7.5x10^{-10}$	$7.9x10^{-10}$ - $1.6x10^{-9}$	$1.3x10^{-7}$ - $2.6x10^{-7}$
methylene chloride	$2.1x10^{-8}$ - $4.2x10^{-8}$	$4.4x10^{-8}$ - $8.8x10^{-8}$	$1.5x10^{-6}$ - $3.1x10^{-6}$
1,1-dichloroethene	ND	ND	ND
chloroform	$2.7x10^{-9}$ - $5.5x10^{-9}$	$5.8x\ 10^{-9}$ - $1.2x10^{-8}$	$7.2x10^{-7}$ - $1.4x10^{-6}$
trichloroethene	ND	ND	ND
tetrachloroethene	$2.0x10^{-9}$ - $2.3x10^{-9}$	$4.1x10^{-9}$ - $4.9x10^{-9}$	$1.5x10^{-6}$ - $1.8x10^{-6}$
benzo(a)pyrene	ND	ND	ND
TOTAL RISK	$2.6x10^{-8}$ - $5.1x10^{-8}$	$5.5x10^{-8}$ - $1.0x10^{-7}$	$3.9x10^{-6}$ - $6.6x10^{-6}$

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TABLE 8-18
ESTIMATED LIFETIME CANCER RISKS
CALDWELL TRUCKING COMPANY SITE
PAGE SIX

Compound	Surface Water Route Estimated Lifetime Cancer Risk/Person Passaic River Dermal Exposure during Swimming	Accidental Ingestion during Swimming	Ingestion of Fish	Long-Term Ingestion
benzene	NC	NC	NC	NC
methylene chloride	2.9×10^{-13} - 7.1×10^{-12}	6.2×10^{-13} - 1.5×10^{-11}	2.2×10^{-11} - 5.3×10^{-10}	1.3×10^{-9} - 3.0×10^{-8}
1,1-dichloroethene	3.8×10^{-12} - 7.9×10^{-11}	8.1×10^{-12} - 1.7×10^{-10}	4.2×10^{-10} - 8.8×10^{-9}	1.6×10^{-8} - 3.4×10^{-7}
chloroform	9.6×10^{-12} - 2.6×10^{-10}	2.0×10^{-11} - 5.4×10^{-10}	2.5×10^{-9} - 6.8×10^{-8}	4.1×10^{-8} - 1.0×10^{-6}
trichloroethene	5.1×10^{-12} - 1.4×10^{-10}	1.1×10^{-11} - 2.9×10^{-10}	2.3×10^{-9} - 6.3×10^{-8}	2.2×10^{-8} - 5.8×10^{-7}
tetrachloroethene	1.6×10^{-12} - 3.2×10^{-11}	3.3×10^{-12} - 6.7×10^{-11}	1.2×10^{-9} - 2.5×10^{-8}	6.7×10^{-9} - 1.4×10^{-7}
benzo(a)pyrene	1.1×10^{-11} - 6.1×10^{-10}	2.3×10^{-11} - 6.3×10^{-10}	3.5×10^{-6} - 9.8×10^{-5}	4.8×10^{-8} - 1.3×10^{-6}
TOTAL RISK	3.1×10^{-11} - 8.2×10^{-10}	6.6×10^{-11} - 1.7×10^{-9}	3.5×10^{-6} - 9.8×10^{-5}	1.4×10^{-7} - 3.4×10^{-6}

Notes:

ND = Not Detected
NC = Not Calculated; compound was not detected in monitoring well samples used to estimate the concentration of contaminants in the *Passaic River*.

Calculations are limited to those compounds for which an evaluation has been conducted by the EPA Carcinogenic Assessment Group (CAG).

Sample calculations are provided in Appendix G.

Risk addition assumes that (1) individual intakes are small, (2) there are no synergistic or antagonistic chemical interaction, (3) individuals will be exposed to all contaminants detected, and (4) all of the compounds induce carcinogenic effects in humans (USEPA, 1985a, IFR Inc., 1985). A discussion of the additive risks associated with the exposure pathways of concern follows.

8.4.2.1 Groundwater Route - Contaminant Plume

Although the data indicate not all receptors are presently exposed to significant levels of hazardous constituents in drinking water, the risks presented represent the upper-bound, worst case range of risks associated with potential long-term exposure to contaminated groundwater. The total additive risks associated with long-term ingestion and inhalation are

	RW-001	RW-002	RW-003	RW-004
Ingestion of Contaminated Drinking Water	1.4×10^{-2}	1.4×10^{-2}	2.5×10^{-6}	5.5×10^{-6}
Inhalation During Showering	2.6×10^{-2}	2.2×10^{-2}	4.0×10^{-6}	8.6×10^{-6}

Residential wells RW-001 and RW-002 are not believed to be used for drinking purposes, but used for outdoor use such as lawn watering, car washing, etc. Consequently, the risks presented for these receptors are overstated. However, receptors outside the plume who use groundwater for drinking could potentially be exposed at some future time if contaminants migrate due to lateral dispersion and/or localized pump influences.

There are no quantitative data to estimate risk associated with exposure during nonpotable or industrial uses of contaminated groundwater. However, exposure is likely to be associated with a certain carcinogenic risk. The magnitude of the risk would depend upon the frequency and duration of exposure.

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8.4.2.2 Groundwater Route - Municipal Well No. 7

The total estimated range of lifetime carcinogenic risks associated with ingestion and inhalation of contaminants detected in Muncipal Well No. 7 are

	Average Concentration	Maximum Concentration
Ingestion of Contaminated Drinking Water	9.3×10^{-4}	1.1×10^{-3}
Inhalation During Showering	1.5×10^{-3}	1.7×10^{-3}

It must be emphasized that Municipal Well No. 7 is presently not used as a source of public drinking water. Consequently, there are no receptors exposed via this route. The risks presented represent the "worst-case" range of lifetime carcinogenic risks if receptors would be exposed to the observed concentrations of hazardous constituents.

8.4.2.3 Wastes

The total estimated range of lifetime cancer risks associated with dermal contact with or accidental of wastes from the existing lagoon are

Dermal Contact	6.8×10^{-5} - 3.7×10^{-3}
Accidental Ingestion	5.3×10^{-6} - 1.6×10^{-3}

These estimates represent the risks associated with exposure under "worst-case" exposure scenarios. With the exception of contaminated surface soils adjacent to the lagoon, waste materials are presently covered thereby limiting the potential for human exposure.

8.4.2.4 Soil Route

The total estimated range of lifetime cancer risks associated with dermal contact with or accidental ingestion of onsite and offsite surface soils and sediments are:

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	Onsite Soil	Offsite Soil
Dermal Contact	7.7×10^{-5} - 2.7×10^{-2}	6.7×10^{-5} - 4.0×10^{-3}
Accidental Ingestion	6.1×10^{-6} - 1.1×10^{-2}	5.1×10^{-6} - 1.8×10^{-3}

These estimates represent the risks associated with exposure under "worst-case" exposure scenarios. The volatile organic compounds detected in onsite or offsite soils and sediments pose relatively low carcinogenic risks. Of primary concern, are the presence of the PCBs in onsite soil and sediments and in sediments detected in the unnamed tributary of Deepavaal Brook. The presence of several carcinogenic PAHs in onsite surface soil may increase the risks to receptors.

8.4.2.5 Surface Water Route

The total estimated range of lifetime cancer risks associated with exposure to site-associated compounds in surface water are

	Deepavaal Brook	Passaic River
Dermal Exposure During Swimming	2.6×10^{-8} - 5.1×10^{-8}	3.1×10^{-11} - 8.2×10^{-10}
Accidental Ingestion During Swimming	5.5×10^{-8} - 1.0×10^{-7}	6.6×10^{-11} - 1.7×10^{-9}
Ingestion of Fish	3.9×10^{-6} - 6.6×10^{-6}	3.5×10^{-6} - 9.8×10^{-5}
Long-term Ingestion	-	1.4×10^{-7} - 3.4×10^{-6}

These risks represent the "worst-case" lifetime carcinogenic risks to local or distant populations who use the Passaic River or Deepavaal Brook. Considering the risks an individual encounters during daily activities, exposure to site-associated compounds in the Passaic River and Deepavaal Brook poses relatively low carcinogenic risks.

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The estimated risk (10^{-6} to 10^{-5}) associated with ingestion of fish from the Passaic River is considered to be significantly overstated. This risk level is due to the estimated concentration of benzo(a)pyrene (BAP) in the river. BAP was detected in the monitoring well used to estimate surface water concentrations; however, its detection most likely is due to soil organic matter that may have been collected with the sample. BAP readily absorbs to soil organic particles and is unlikely to be found in the Passaic River at the estimated concentration. Consequently, the risks to receptors who consume fish from the Passaic River are likely to be significantly lower than those estimated.

The detection of several known or suspected carcinogenic compounds (several of the volatile organics, benzo(a)pyrene, and arsenic) in the intermittent tributary of Deepavaal Brook (SW-007) is also of concern. There are no data to estimate carcinogenic risk associated with infrequent direct contact exposures to these compounds under site-specific exposure scenarios. However, receptors, particularly children, who come into contact with surface waters adjacent to the site on a daily basis, may be at risk.

8.4.3 Environmental Risks

8.4.3.1 Aquatic Biota

Aquatic life in the Passaic River, Deepavaal Brook, and the unnamed tributary of Deepavaal Brook are unlikely to be adversely affected by the presence of site-associated HSL organic contaminants. A comparison of observed or estimated concentrations of organic contaminants in these surface water bodies to the Ambient Water Quality Criteria for the protection of freshwater aquatic life indicates acute or chronic toxic effects to aquatic biota are unlikely.

However, the presence of several inorganic contaminants may be of concern. Table 8-19 presents the concentration ranges of cadmium, chromium, lead, and silver detected in these surface water bodies. Of the contaminants identified

TABLE 8-19

FRESHWATER AQUATIC TOXICITY
CALDWELL TRUCKING COMPANY SITE

Compound	Concentration Range (ug/l)	Ambient Water Quality Criteria	
		Acute Effects	Chronic Effects
cadmium[c][d]	6.8 - 19	6.6	6.6
chromium[a][c][d]	15 - 44	Cr VI - 11	Cr VI - 7.2[f]
lead[a][b][c][d]	7.2 - 634	99.9[c]	3.9[f]
silver[b][c][d]	11 - 53	7.2[g]	0.12

Notes:
(a) Detected in the Passaic River
(b) Detected in Deepavaal Brook upstream of the site
(c) Detected in Deepavaal Brook downstream of the site
(d) Detected in the unnamed tributary of Deepavaal Brook
(e) Maximum concentration in a 30-day period
(f) Average concentration in a 30-day period
(g) Instantaneous maximum concentration

Sources: USEPA, 1980
USEPA, 1984b

during sampling, these compounds exceed the AWQC for the protection of aquatic life. Based on this comparison, chronic effects to aquatic biota are possible.

However, these criteria are primarily based on the dissolved concentration of an inorganic compound in surface water. Surface water samples collected during the RI were unfiltered prior to preservation in acid for metal analysis and reflect the total metal concentration (in water and suspended sediments in the sample) rather than the dissolved metal concentration. Consequently, risks to aquatic biota may be overestimated.

8.4.3.2 Terrestrial Biota

Terrestrial biota most likely impacted by site contaminants are domestic animals and typical urban wildlife. Contaminated surface waters are unlikely to pose appreciable risks to environmental receptors. The primary mode of exposure is via direct contact with contaminated soils and sediments.

Of concern is the potential for exposure to site-associated compounds that may bioaccumulate and/or biomagnify in the food chain (i.e., PCBs and lead). Repeated exposure to these compounds in soils and sediments could pose appreciable risks to terrestrial biota.

8.5 Limitations of the Risk Assessment

It must be recognized that the estimation of noncarcinogenic and carcinogenic risks to human and environmental receptors are dependent upon numerous assumptions. Many uncertainties are inherent in the process.

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Limitations and uncertainties associated with this risk assessment are:

- Limitations associated with the chemical data base - Constraints imposed by the chemical analytical procedures such as the lack of the specificity of the data as related to contaminant detections at or near the detection limit, and the inability to determine the form or valence state of inorganic contaminants.

- Limitations associated with the toxicological data base - Most toxicological information is derived from animal studies. Extrapolating data from these studies to expected results in humans is major source of uncertainty. Other sources include those encountered with high-to-low dose extrapolation, interspecies extrapolation, and variations in the sensitivity of sub-groups and individuals.

- Limitations associated with the degree to which exposure may be estimated or predicted - Qualitative and quantitative exposure estimates are based on numerous assumptions including frequency of exposure, duration of exposure, amount of compound absorbed, etc. All of these assumptions are sources of uncertainty in the risk assessment process.

8.6 Public Welfare

The major impact on public welfare is the potential loss of groundwater aquifers as a source of drinking water. Degradation of environmental quality and aesthetic factors are also a consideration.

8.7 Conclusions

A summary of the health and environmental risks associated with the Caldwell Trucking Company Site is presented to focus the evaluation. The risks identified

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are based on the distribution and extent of chemical contamination, the potential for contaminant transport, opportunities for exposure, and the toxicity of the contaminants.

- The major potential health risk at the site is associated with ingestion or domestic use of contaminated groundwater. There would be a potential for acute, chronic, and carcinogenic health risks if the contaminants were ingested or inhaled at the observed concentrations in the most contaminated residential wells. Since all residential well questionnaires were not returned, it is not known if there are any receptors within the plume who use the most contaminated groundwater as a source of potable water. In addition, receptors in the vicinity of the plume may be exposed at some future time due to localized pumping influences or dispersion of the contaminant plume.

- Ingestion or inhalation of contaminated groundwater at the observed concentrations in Muncipal Well No. 7 is likely to be associated with subchronic, chronic, and carcinogenic health risks. Presently, Municipal Well No. 7 is not used as a source of public drinking water.

- Chronic inhalation or direct contact with contaminated groundwater during outdoor nonpotable uses may be associated with adverse chronic or carcinogenic health risks. Risks would depend upon the frequency and the duration of exposure.

- Direct contact with or accidental ingestion of contaminated onsite surface soils may be associated with chronic and carcinogenic health risks. Exposure to offsite sediment in the tributary of Deepavaal Brook is also of concern.

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- Acute and chronic ingestion, or direct contact to surface water in Deepavaal Brook and the Passaic River is unlikely to be associated with adverse health implications. Chronic exposure to contaminated surface waters adjacent to the site is of concern.

- Another possible mode of human exposure is via ingestion in the food chains, i.e., the consumption of aquatic biota in Deepavaal Brook or the Passaic River. The potential for health impacts to local or distant population are considered to be minimal.

- Environmental receptors may be affected by the site. Inorganic compounds are the primary contaminants of concern for aquatic biota. PCBs and lead in onsite and offsite surface soils and sediments could potentially affect terrestrial biota.

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